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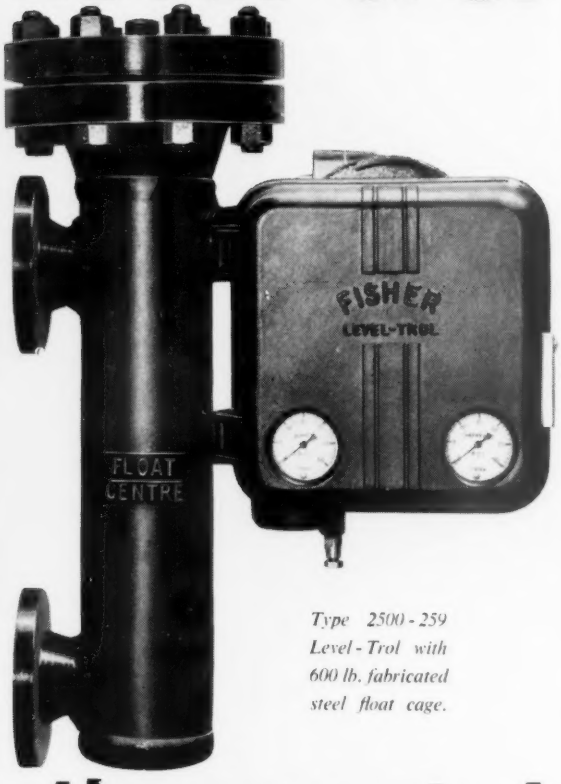

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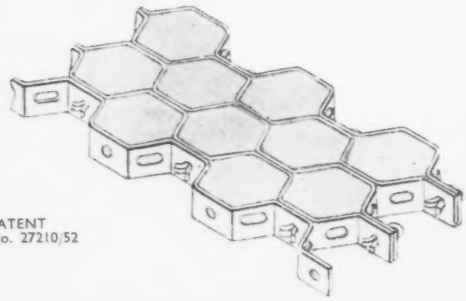

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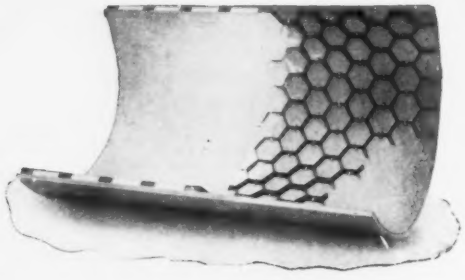

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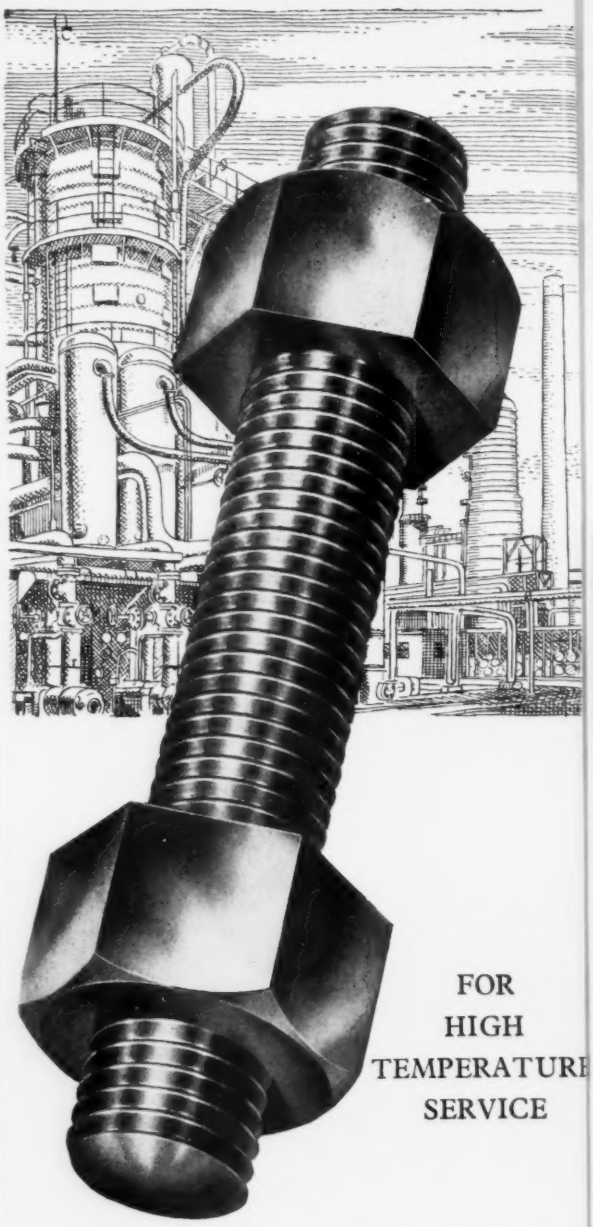

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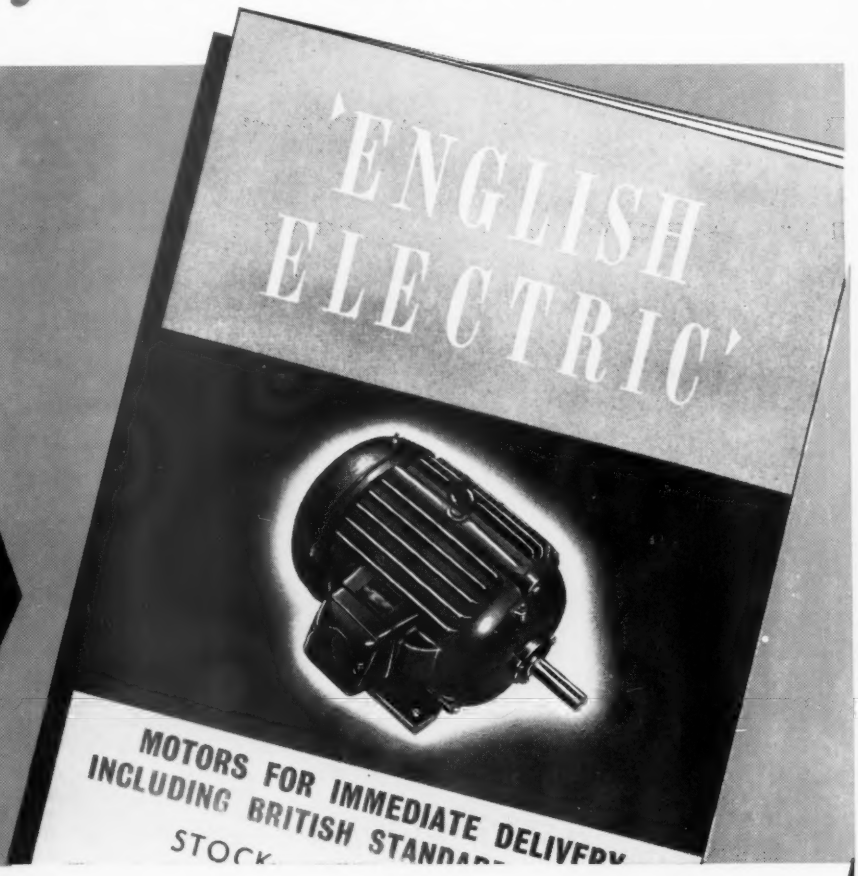

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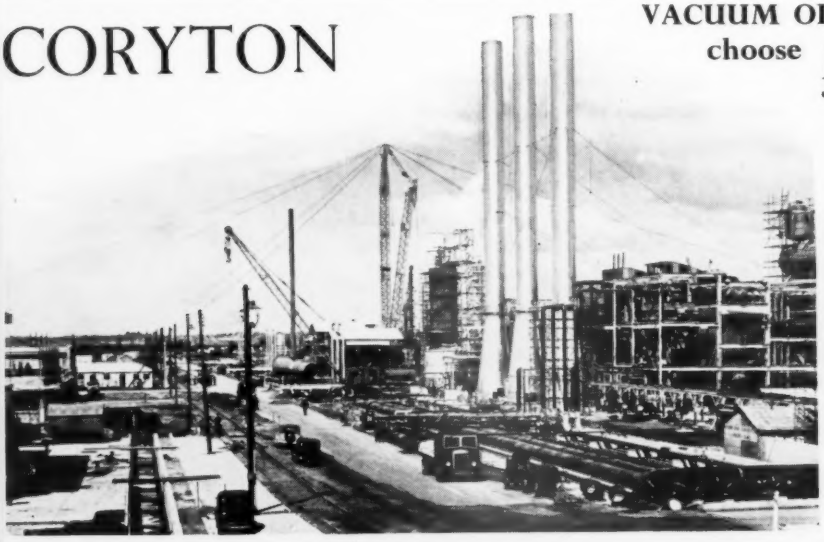

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Europe's Energy in the Future

By A. R. McDOWALL and H. C. L. MASON

Although one of the world's principal consumers of energy, Western Europe has been slow to welcome liquid fuels to supplement its own sources of energy. These are circumstances which acquire added significance when it is considered that although Western Europe's energy production has continued to increase, the rate of that increase has already begun to fall behind the pace set by demand, a pace which may far outstrip it in less than a decade and a half.

It is pertinent, therefore, to consider by what means Western Europe's additional future energy requirements may be met. In order to do this some estimate must first be formed of current requirements and what such requirements are likely to be in the future.

Naturally any forecast of energy requirements would be completely vitiated by the outbreak of a large-scale war or by the recurrence of a severe depression such as that of the 1930's. For present purposes it has been assumed that no war will take place; a good deal of faith has also been pinned on the determination and ability of Governments to avert slumps by exerting their powers and applying bold remedies. Whilst fluctuations are perhaps inevitable, there are good reasons for thinking that disastrous declines in industrial activity are unlikely to occur. On these premises it has been assumed, in the remainder of this article, that the long-term trend of economic activity will be progressively upward.

Demand

The level of demand for a basic commodity, such as energy, is particularly associated with the level of economic activity. In industrialized regions indication of the trend of economic activity is provided by the trend of industrial production. Possible levels of energy demand in the future may be determined, therefore, by considering possible levels of industrial production.

Although bedevilled since the turn of the century by two world wars and periods of depression, the rising trend of Western European industrial production during periods of peace has averaged some 3 per cent per annum—in recent, and perhaps abnormal, years the rate has been much higher. Under the circumstances, it seems reasonable to suppose that the future trend will increase at not less than past rates, that is to say, at a yearly minimum of 3 per cent. In fact, the figure may be higher taking into account that recent trends have been in excess of 4½ per cent. It is not considered likely, however, that the rate of increase would be greater than that. Growth of industrial production taking 3 and 4½ per cent as extreme rates is illustrated in Chart I.

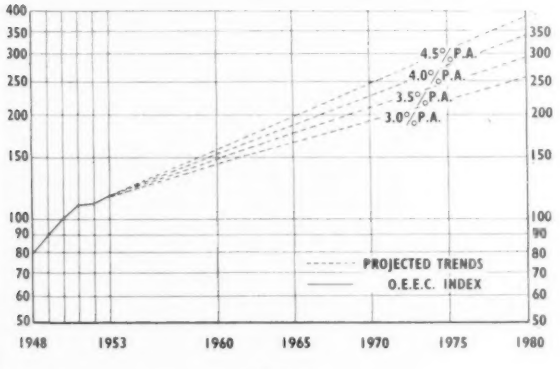


Chart I
Western Europe—Industrial Production
(1950=100).

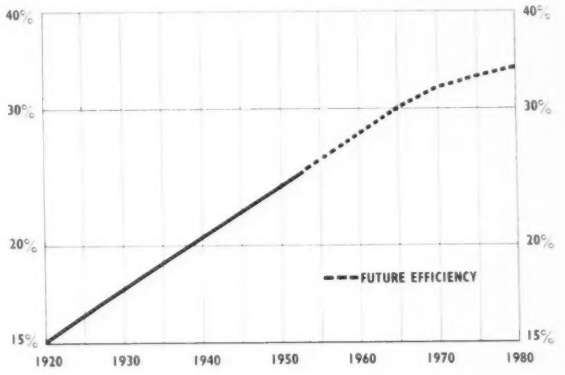


Chart II
Weighted average efficiency of energy utilization in Western Europe.

Industrial Production and Energy Consumption

Hitherto an increase in industrial production of the order of 10 per cent has been associated with a corresponding rise in energy demand of about 6 per cent. The relationship is, of course, brought about by a wide range of factors. Prominent among these are the growth of populations, *per capita* consumption, and efficiency in the use of energy. It is axiomatic that demand for any commodity must be related to the number of consumers and hence, in the case of energy, to the size of population. As there is no apparent reason for expecting any marked change in the rate of growth of the populations of Western Europe during the next quarter century the effects of that factor may be expected to continue as in the past.

The most significant feature of annual energy consumption per person in Western Europe in the past was its steadiness. For example, in the United Kingdom consumption *per capita* in recent years of 4¾ tons (h.c.e.*) is little different from that of 1917 when it stood at 5½ tons, a figure only slightly higher than that of the year 1883. The case of Germany is similar.

*Hard coal equivalent; all tonnage figures given are in terms of this unit.

Here rising rapidly from ½ ton in 1860, the general trend has shown no gain since 1913 when consumption stood at 3½ tons per person. Evidence at present available suggests a definite tendency for consumption *per capita* to level off in industrialized countries. Whether or not this will be the case in Western Europe during the next quarter-century is as yet uncertain.

While energy consumption *per capita* has been steady, it must be appreciated that it has remained so under conditions of constantly rising efficiency in energy utilization which recent research suggests will continue until 1965, increasing thereafter at a diminishing rate. (See Chart II.)

In the light of these broad factors a forecast has been made of the feasible trend of energy demand in Western Europe over the next quarter of a century. This is illustrated in Chart III and shown in tabular form in Table I.

TABLE I

WESTERN EUROPE—ENERGY CONSUMPTION 1953–1980
(million metric tons coal equivalent)

Annual percentage increase in industrial production	1953	1960	1965	1970	1980	*Approximate corresponding percentage increase in energy consumption*
3.0		802	885	996	1377	2.5
3.5	705	820	921	1057	1525	3.0
4.0	(actual)	839	960	1123	1693	3.25
4.5		857	1000	1194	1882	3.75

For reasons discussed earlier, it is emphasized that of the four series, shown in the table, that applicable to a 3 per cent per annum rise in industrial production may be regarded as a

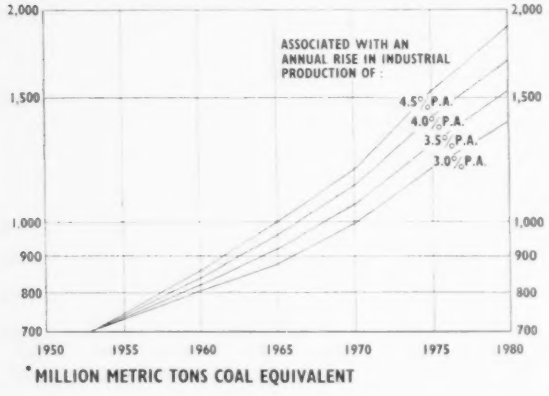


Chart III
Western Europe—Energy Demand

minimum—the corresponding increase in energy consumption over the period being 2.5 per cent. It may well be the case, of course, that the minimum will be exceeded; it is unlikely that the maximum will be surpassed.

Energy Supplies

How are current energy demands now being met and what supplies of energy will be available in the years ahead?

Apart from oil, the principal forms of energy in 1953 were coal, hydro-electric power, and natural gas.

Coal and Lignite

Some 528 million tons of coal and lignite were consumed in Western Europe during 1953. Although additional amounts will be forthcoming in the future, the coal industry is beset by many hampering problems such as diminishing accessibility of seams and increasing extraction difficulties; poor labour supply prospects; the hazardous nature of mining and general aversion to the occupation, as well as a general shortage of mining engineers, which, to mention only a few, militate against any spectacular production increase. Although the greater part of coal and lignite consumption in Western Europe is accounted for by the European Coal and Steel Community (E.C.S.C.)—consuming 50 per cent—and by the U.K.—which takes 40 per cent—it is already apparent that these regions cannot expand their production to keep pace with foreseeable demand. Although the High Authority of the E.C.S.C. estimates that demand will rise by 20 million tons in the four years 1953–57—an average of 5 million tons per annum—it is doubtful whether supply will meet demand; in the United Kingdom it is already officially acknowledged that supplies—here estimated to reach 230 million tons by 1960—will not meet the demand of 236 million tons per year estimated to prevail during 1959-63.

In the light of these considerations the following tentative estimates of supply of coal and lignite are put forward as broad indications of the possible supply outlook for solid fuels in Western Europe.

1953	1960	1965	1970	1975	1980	million m.t. hard coal equivalent
528 (actual)	575	610	645	680	710	

Hydro-electricity

Since the end of the last war Western European hydro-electric developments have been extensive. It is, however, officially recognized that the rapid increase in supplies over recent years cannot be expected to continue, mainly because the most suitable sources of power have already been harnessed. While, technically speaking, abundant opportunities for exploitation still exist, capital needs may well be greater and development less striking than in the past. Again, for the purposes of the study, the following broad figures are used to demonstrate the outlook for hydro-electric supplies:—

1953	1960	1965	1970	1975	1980	million m.t. hard coal equivalent
82 (actual)	110	125	140	160	170	

Natural Gas

The contribution made by natural gas to Western Europe's energy requirements is very small, although supply has increased tenfold since 1946. Discovery of natural gas was made more by accident than design, having been found largely during unsuccessful exploration for oil. As incentives to search for natural gas grow stronger, however, exploration will doubtless intensify; obviously substantial discoveries would markedly alter the energy picture.

Import of Middle East gas by pipeline, although technically feasible, is a venture necessitating vast capital expenditure for which favourable conditions in international affairs, that by no means can be foreseen, are an essential prerequisite. Even so the possibilities of Western European production would have first to be exhaustively tested. The alternative of shipping Middle East gas in cold liquefied form is still only a remote possibility. Under the circumstances, it is only possible to speculate on the contribution which may be made. In general, it appears that the future contribution will remain small, in which case the picture may well be as follows:—

1953	1960	1965	1970	1975	1980	million m.t. hard coal equivalent
4 (actual)	10	15	20	25	30	

Atomic Energy

Scientific progress made in recent years leaves little doubt that power from the atom will become a commercial and economic reality, perhaps within the next ten years, and that it will *eventually* become a most important contributor of energy. The extent to which such energy will be produced between say 1965 and 1980 is as yet quite hypothetical.

The field into which atomic energy appears the most likely to emerge is in the production of steam in large quantities. For example, in generating electricity it may well tend to supplant or supplement coal and hydro-electric power, especially if, as seems probable, development of the latter becomes increasingly costly. It seems reasonably safe to assume, however, that during the period under review, atomic energy could not do more than make a minor contribution to the vastness of future demand.

Oil Products

Following a spectacular post-war expansion, consumption of main products last year reached some 91 million metric tons (h.c.e.). Future estimates of demand up to 1959 indicate an increase of about 4 million tons per year. It is not envisaged that there will be any difficulty in providing the requisite additional supplies. Working on the assumption that the increase in supplies, anticipated up to 1959, is projected to 1980 and on the completely hypothetical assumption that the product demand pattern remains unchanged, the estimate of supplies shown below is obtained:—

1953	1960	1965	1970	1975	1980	million m.t. hard coal equivalent
91 (actual)	120	140	160	180	200	

Total Supply

These broad estimates of future energy supplies have been summarized in Table II. It is emphasized that the estimates are largely tentative and should be regarded as having been made solely with the object of illustrating the order of magnitude anticipated. No attempt has been made to form a quantitative estimate of atomic energy, owing to the overwhelming uncertainties of the situation.

TABLE II

WESTERN EUROPE—FUTURE ENERGY SUPPLIES
(million m.t. hard coal equivalent)

	1953	1960	1965	1970	1975	1980
Coal–Lignite	528	575	610	645	680	710
Oil products	91	120	140	160	180	200
Hydro-electricity . . .	82	110	125	140	169	170
Natural gas	4	10	15	20	25	30
	705	815	890	965	1045	1110

Supply and Demand

A comparison of the Western European Energy Demand shown in Chart III and in Table I with the estimate of future supplies (Table II) indicates that by about 1964 the minimum level of demand anticipated may be met by supplies available, but thereafter such supplies will become progressively inadequate. The situation is illustrated in Chart IV.

It is to be observed that the minimum demand for 1965 is based upon an average increase in energy demand a little short of 2 per cent p.a. from 1953-1965. A slightly larger increase in the rate to 2½ per cent p.a. (corresponding to 950 million tons in 1965) would result in the indicated supply falling some 64 million tons short of demand. From the longer term outlook, that is to say, from 1965 to 1980, there is, on the basis of the figures employed, likely to be a far more significant shortage of energy. Judged from the standpoint of the minimum expected demand, the potential shortfall is prodigious, but the upper limit of the range transcends even that by 500 million tons, implying a total shortage of some 800 million tons—considerably more than present consumption!

Conclusion

The astronomic figures associated above with future demand, while subject to adjustment in the course of time, may nevertheless be regarded as a clear indication of the height to which consumption may rise; as such they serve to throw

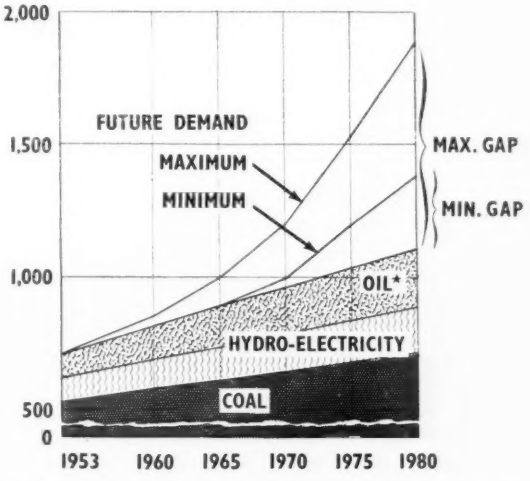


Chart IV
Western Europe—Future Energy Supply and Demand.*
(Figures in million metric tons coal equivalent.)

into sharp relief the magnitude of potential demand and the limited contribution which hydro-electricity and atomic energy are likely to be able to make to alleviate the threatened deficiency. Since the growth of the coal industry's production is also unlikely to rise in proportion to total energy requirements, the task of meeting these marginal needs must fall principally on the oil industry.

It is envisaged that the process by which oil will come to play a larger part on the Western European scene will be mainly an evolutionary one. Use of refined petroleum products, although costing relatively more than coal, can be justified by reason of their greater efficiency when used in the appropriate equipment. As demand for available coal increases, so will coal come to command a higher price, an inducement which should encourage the consumer to face the appreciable capital outlay normally associated with conversion to oil-burning equipment. Two of the fields in which the growth of oil consumption may be anticipated, to judge from experience in the U.S.A., are perhaps domestic heating and diesel locomotion.

The ability of the oil industry to make available substantially increased quantities of products is undoubted, provided that it earns an economic return on each and every product. The power of the industry to provide the needed additional quantities of fuel oil, however, will be frustrated unless larger markets for the lighter products are allowed to develop and the relationship between motor gasoline and fuel oil prices moves in favour of the latter.

It is characteristic of the vitality and resourcefulness of the industry that it has been able to respond swiftly to demands placed upon it in past straits; provided it is given freedom to tackle the task ahead, who doubts that European progress in the future will be assured?

New and Forthcoming IP Publications

Modern Petroleum Technology

It is now eight years since the first edition of this publication made its appearance and it has proved a useful addition to the literature of petroleum, particularly for those who wished to gain some knowledge of the technicalities of the industry without the need for a deep scientific study. In the meantime, there have been considerable and major advances and changes in the technology of petroleum. Methods of exploration for oil sources and the means of its production have improved, new and more efficient refining processes have enabled the changing requirements of the user to be met, and new methods of utilization have been developed.

These advances and improvements are dealt with in a second edition of "Modern Petroleum Technology", which will be as up-to-date as the time required to produce such a volume permits. The first edition contained 466 pages; this new volume, which was published in December, contains 700 pages and its price is £1 10*s*. post free to members of the IP and £1 15*s*. to others.

Marketing Safety Code

Second in the series of Model Codes of Safety Practice in the Petroleum Industry is the "Marketing Safety Code", which deals with recommended practices in the design, equipment, and operation of installations and depots, in the transport of petroleum by road and rail, and at kerbside pump installations. Later a chapter on the handling of liquefied petroleum gases will be added.

This publication is issued in loose-leaf form, punched for insertion in the cover provided with Part I (Electrical Code), the price for the Code alone being 10*s*. 6*d*. post free to IP members and 12*s*. 6*d*. to others. Prices for the Code and the Binder are £1 1*s*. to IP members and £1 6*s*. to non-members. The binder is not separately available.

Applied Mass Spectrometry

In October 1953 the Mass Spectrometry Panel of the IP Hydrocarbon Research Group held its second conference on mass spectrometry, the emphasis on this occasion being on application of the technique in the petroleum industry.

A total of twenty-one papers were presented by leading spectroscopists and discussed by an audience of nearly 150 persons from many countries. These papers, several of which did not appear as pre-prints, together with a report of the discussions, are contained in a new publication now in the press which will be available to members of the Institute at £2 post free, and to others at £2 10*s*.

Standard Methods

The fourteenth edition of the Institute's "Standard Methods for Testing Petroleum and Its Products" is due for publication in January and will contain details of new methods for Analysis of Oil-Soluble Sodium Petroleum Sulphonates (IP 144); Asphaltenes—Precipitation with Normal Heptane (IP 143); Foaming Characteristics of Crankcase Oils (IP 146); Olefin plus Aromatic Content (IP 145); Phosphorus Content of Lubricating Oil, Additives, and Concentrates (IP 148); Phosphorus in Lubricating Oil—Quinoline Phosphomolybdate Method (IP 149); and Spectrometric Analysis—ASTM 60 ON Test Reference Fuel (IP 147).

A considerable number of existing methods have been amended to varying degrees and the specifications for hydrometers and thermometers have been amended to a considerable extent. The appendix relating to the conversion of kinematic to Redwood viscosity has been revised to accord with the basic change in the viscosity of water at 20°C, and Appendix E, relating to precision data, has been revised.

The methods relating to knock-rating of engine fuels and that for ignition quality of diesel fuel have been removed from the book and are to appear as a separate publication as mentioned below.

Price of "Standard Methods" is £1 15*s*. to members of the IP and £2 to others, both prices being post free.

IP Engine Test Methods for Rating Fuels

For the convenience of laboratory operators and in an endeavour to keep the size of "Standard Methods for Testing Petroleum and Its Products" within reasonable limits, the engine methods for testing motor aviation fuels and diesel fuels are being published separately in future.

The first edition of "IP Engine Test Methods for Rating Fuels" will be published at the same time as the 14th edition of "Standard Methods". It will contain details of the methods for determining ignition quality of diesel fuel (IP 41/55T); two methods for knock-rating of aviation fuels—the Aviation Method (IP 42/55T) and the Supercharge Method (IP 119/55T); two methods for motor fuels—the Motor Method (IP 44/55) and the Research Method (IP 126/55); and a new method, Knock-Rating of High Performance Fuels—Extended Motor Method (IP 150/55T), which replaces the 25° Motor Method.

Price of this new publication is £1 net, including postage.

Petroleum in Modern Transport

It is also hoped that the full report of the 1954 Summer Meeting of the IP will be available in January, under the title of "The Rôle of Petroleum in Modern Transport". As the title indicates, this book of nearly 200 pages will contain the nine papers which were read at Llandudno in May 1954 and which present the latest thought on the use of petroleum products in the transport industry, the properties and requirements of fuels and lubricants used for rail, road, air, and sea transport, and an indication of the future trends in the quality of these products.

A Glossary

In 1951 the IP published the first edition of "A Glossary of Petroleum Terms". Since that time the Nomenclature Sub-Committee has given further consideration to the matter and a second edition is in process of publication. It will contain many additional terms and revisions of some of the definitions given in the first edition. Price will be 2*s*. 6*d*. net and post free.

Other IP Publications

Other publications of the Institute include: "Post-war Expansion of the U.K. Petroleum Industry" (£1 to members, £1 5*s*. to non-members); "Significance of Properties of Petroleum Products" (6*s*. to members, 7*s*. 6*d*. non-members); "Petroleum Measurement Manual" (£1 2*s*. 6*d*. to members, £1 5*s*. non-members). Post free in all cases.

The Cadman Lecture and Medal

On 17 November 1954 before a large audience in the lecture hall of the Royal Institution of Great Britain, C. A. P. Southwell, C.B.E., M.C., B.Sc., managing director of the Kuwait Oil Company Ltd. and a Past-president of the Institute of Petroleum, delivered a Cadman Lecture and received a Cadman Medal.

The Lecture

The subject of the lecture was "Winning Petroleum" and, in his preliminary remarks, Mr Southwell expressed his deep appreciation of the honour conferred on him, particularly in view of its international character. It provided additional gratification, said Mr Southwell, that only a student of Professor Cadman, as he was then, could feel, for to one of his students it was the "medal of a master".

Lord Cadman was a real pioneer in approaching the petroleum problem from the viewpoint of scientific exploration and orderly development of a mineral deposit.

The most significant development in the petroleum industry in recent years had been the increasing world demand for petroleum products. Estimated requirements for 1954 were 685 million tons and the present rate of growth of requirements was 5 per cent per annum. There was no serious possibility of this rate continuing for the next 50 years and a more probable estimate was an average of 3 per cent per annum. This meant that just over 2000 million tons per annum—about three times the present world production—would be required by the end of the century.

Turning to some of the problems involved in providing these large quantities of crude oil, Mr Southwell said that the key to future search was in the fundamental knowledge of the origin of oil and the conditions under which it was found. Reviewing the last 35 years, Mr Southwell said the main change "is that the relatively thin veneer of sediments covering a great part of the surface of the earth is providing, as new sources are found, every possible type of oil reservoir, both structurally and in regard to rock texture, and this has widened considerably not only the scope of the search, but also views on the extent of oil reserves yet to be found. Reports made some time ago to the United Nations Scientific Conference on Fuels stated that the present estimates of the amount of undiscovered reserves of oil are of the order of 500 times the current annual world consumption, *i.e.* over 300 thousand million tons. Such estimates reflect improvements in technical development, and the optimism of geological thought."

Authorities agreed that an area of up to 6 million square miles of sedimentary land surface might be worth prospecting for oil accumulations, to which must be added at least an equal area comprising the continental shelf lying off-shore of the land sedimentary rocks—an area of not less than 12 million square miles in all.

"Taking this vast area as a basis, American petroleum geologists have approached the problem from a global viewpoint, and estimating the cubic miles of sedimentary rocks, have applied an average figure of oil content per cubic mile of sedimentary rocks, based on evidence in the U.S. which has been very widely tested by the drill. Estimates vary according to the optimism of the scientist concerned, and may be as much as 12,000 tons of oil per cubic mile. Using such statistics, a deduction can be made that the undiscovered oil remaining in the world amounts to between 100 and 200 thousand million tons."

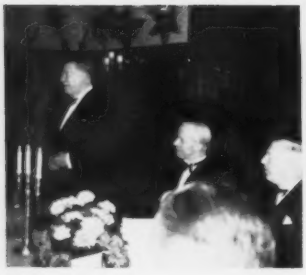
Opinions had been expressed that two-thirds of the marine sedimentary rocks of the earth's crust, in which oil might be found were located on the continental shelf "but no more than a very general idea of economic reserves can be given at this early stage for those areas lying in deep water outside proved oil provinces."

But despite the satisfactory picture that had been painted of future oil reserves, the petroleum industry "continues to stimulate research and investigation, involving very great expenditure in improving the technique of 'finding' and 'proving' additional sources of raw material."

Mr C. A. P. Southwell (left) *receiving the Cadman Medal from Colonel S. J. M. Auld.*

On improved techniques in finding new oilfields, Mr Southwell mentioned under-water geophysical operations, the flying magnetometer, and new deep drilling techniques. He then discussed the work of the reservoir engineer, whose function was to watch the effect of the removal of oil and gas from the underground formations, and the consequent changes resulting from such production. "Whilst undeveloped reserves of oil are still in the minds of the geologists, the major oil reservoirs found by them are now being developed under the experienced control of reservoir engineers." The empirical science of reservoir engineering had been developed to a stage where "the basic knowledge can be employed with confidence in planning reservoir development, and in increasing the productivity of oilfields from 20 per cent recovery to as high as 80 per cent where conditions are suitable."

The size and type and relative simplicity of the structures with which British petroleum engineers had to deal in early Middle East developments, had left their mark on the way the engineers thought; they were able to produce large oilfields as units, with no sand problems to contend with, and no question of multiple reservoirs. "It is fair to say that the reservoir engineering outlook, as pioneered by the British in



At the Cadman Dinner the toast to Mr C. A. P. Southwell was proposed by Colonel S. J. M. Auld, seen here (left) *during his speech, with Sir John Maude and J. W. Platt;* in the centre *J. A. Jameson is speaking, with A. C. Hartley to the left and J. A. Oriel and D. M. S. Langworthy to the right;* in the right-hand picture *Sir John Maude is speaking.*

the Middle East, has been built up on the experience that one can treat these very large structures as a physical entity for most purposes. The result has been to develop a confidence in the ability to predict and control the behaviour of large oilfields."

The confidence and outlook that had been gained by the study of large structures had been a very valuable adjunct to the planning of new fields as energy units. In a large sandfield such as the main Kuwait oilfield, it had been possible, "given the faith which underlies the early experience in the Middle East limestone fields, combined with the practice and scientific understanding of sand reserves problems developed in America, to predict with confidence that the oil and water inside the field will, in general, be able to flow in the reservoir in a regular and not an arbitrary manner and to establish . . . the exact behaviour of the average well, as predicted over many years, and the movement of the reservoir fields".

Within recent years, a most powerful tool had been added by American scientists to the equipment of the reservoir engineer. This was the electrical reservoir analyser, by means of which it was possible to predict with a useful degree of accuracy what would be the future producing history of an oil reservoir over an interval equal to that during which its past history was known.

In conclusion, Mr Southwell expressed his humble appreciation of the privilege afforded him of standing at the historic table in the hall of the Royal Institution of Great Britain.

The Presentation

At the conclusion of the lecture, the chair was taken by Colonel S. J. M. Auld, O.B.E., M.C., D.Sc., who, before presenting the Cadman Medal to Mr Southwell, said that the pleasure of listening to the lecture had been enhanced by reason of its having once more closely associated two men who in the past were personally so intimately connected—the late Lord Cadman and Philip Southwell.

"The recommendation by the Awards Committee of the Institute that Mr C. A. P. Southwell be invited to receive the Medal and to give the Fourth Cadman Lecture was unanimous. So also was the decision of my immediate predecessor as President of the Institute of Petroleum and his Council. A better or more suitable choice could not have been made. Not only has Mr Southwell distinguished himself in the sphere of petroleum, but he has done so in the true Cadman tradition and has thereby brought honour not only on himself but also on the Institute of Petroleum, on the British petroleum industry, and to his country.

"I do not propose epitomizing Mr Southwell's petroleum career as geologist and mining engineer in those sort of places in the world where oil is found. I will not dwell upon his successive successes in the field, nor his ability as a man of science to deal with and handle the toughest factors in oilfield and oil production development.

"I would like rather to refer to his most recent and more spectacular achievements of which today he has given us a glint. Here is a man who never sought the limelight on the stage of life but who, when it did fall upon him, could be depended upon to be seen, as Ecclesiastes enjoined—"doing with his might that which his hand found to do"—and doing it as I have said before, "with his device, his knowledge, and his wisdom."

"Mr Southwell was able, by near heroic efforts during the war, to develop our tiny English oilfield at Eakring to a stage where its output gave us a key proportion of the highly specialized oils essential to the R.A.F. Hardly without breathing space he was to be found, with the same absence of show, developing a field with a present production 400 times that of Eakring; done, moreover, under conditions of stress, and shortage of material, and political difficulty which emphasize the credit due. Due, may I put it, to the wisdom of the successive Kuwait Rulers, the joint British-American Company operating, and Philip Southwell.

"Philip Southwell, you have done much to deserve our thanks for your perpetuation of the name and tradition of John Cadman, first Lord Cadman of Silverdale, the famous leader whom we are here to praise. It gives me the greatest pleasure to present you with the Cadman Medal."

Mr Southwell received the Cadman Medal amid prolonged applause and then thanked Colonel Auld for his remarks and his audience for their attention.

The Cadman Memorial Medal

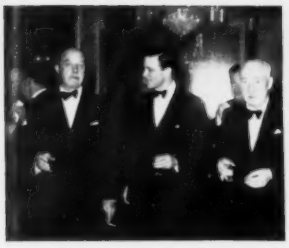
The Cadman Memorial Fund, which was contributed by colleagues and friends of the late Lord Cadman of Silverdale, chairman of the Anglo-Iranian Oil Company Ltd. and a Past-President of the Institute, provides for the endowment of a Memorial Lecture to be given at least once every three years and for the presentation of a Medal. The award is made by the Institute of Petroleum as trustees of the Fund and the lecturer is selected because of his special knowledge and outstanding contribution to the petroleum industry. The lecturer may be of any nationality.

The first Medal was awarded in 1946 to Sir William Fraser, C.B.E., chairman of Anglo-Iranian Oil Company Ltd. The second award was in 1947 to Robert Price Russell, president of Standard Oil Development Company, whose lecture was entitled "Progress in Petroleum Research". In 1951 the Third Medal was awarded to Robert E. Wilson, chairman of the Board of the Standard Oil Company (Indiana), who spoke on "Competitive and Co-operative Research in the American Petroleum Industry".

The Cadman Dinner

Subsequent to the lecture, Mr Southwell was guest of honour at a dinner presided over by Colonel S. J. M. Auld and held at the Hall of the Armourers and Brasiers Company.

Those present were: Sir John Maude (*Permanent Secretary,*



Among those who attended the dinner given to Mr C. A. P. Southwell (left) *were Sub-Lt John Southwell, J. S. Parker, E. C. Masterson, P. Anderson, J. A. Jameson, H. S. Aspinall, Dr E. B. Evans, N. W. Grey, S. Collier, C. M. Vignoles, N. A. Gass, and Victor Butler.*

Ministry of Fuel and Power); Victor Butler (*Under-Secretary, Ministry of Fuel and Power*); P. Anderson; H. S. Aspinall (*English Electric Co.*); E. Aylwin (*Midland Tar Distillers Ltd.*); M. A. L. Banks (*Anglo-Iranian Oil Co. Ltd.*); J. P. Berkin (*director, The Shell Petroleum Co. Ltd.*); Hon. M. R. Bridgman (*director, Kuwait Oil Co. Ltd.*); F. C. Bowring (*chairman, Lobitos Oilfields Ltd.*); F. P. Chambers (*managing director, Imperial Chemical Industries Ltd.*); S. Collier (*managing director, Cleveland Petroleum Co. Ltd.*); J. M. Cooper (*Kuwait Oil Co. Ltd.*); C. T. Digby-Jones (*Messrs Smith and Williamson*); G. W. Dunkley (*executive director, Iraq Petroleum Co. Ltd.*); W. E. Eadie (*assistant managing director, Burmah Oil Co. Ltd.*); Dr P. H. Frankel (*director, Manchester Oil Refinery Ltd.*); N. A. Gass (*managing director, Anglo-Iranian Oil Co. Ltd.*); J. C. Gridley (*chairman, Vacuum Oil Co. Ltd.*); G. H. Herridge (*executive director, Iraq Petroleum Co. Ltd.*); H. A. Holmes (*chairman, London and Thames Haven Oil Wharves Ltd.*); J. A. Jameson; D. M. S. Langworthy (*director, Kuwait Oil Co. Ltd.*); W. F. List (*assistant managing director, C. C. Wakefield & Co. Ltd.*); Sir Godfrey Mitchell (*chairman, George Wimpey & Co. Ltd.*); J. M. Pattinson (*managing director, Anglo-Iranian Oil Co. Ltd.*); J. W. Platt (*managing director, The Shell Petroleum Co. Ltd.*); H. W. Roche (*managing director, Vacuum Oil Co. Ltd.*); L. Sinclair (*chairman, Esso Petroleum Co. Ltd.*); H. E. Snow (*managing director, Anglo-Iranian Oil Co. Ltd.*); Sub-Lt John Southwell; C. E. Spearing (*Anglo-Iranian Oil Co. Ltd.*); F. C. Tickle (*director, Metal Containers Ltd.*); C. M. Vignoles (*managing director, Shell-Mex and B.P. Ltd.*).

Members of Council of the IP present were: E. A. Evans (*Past-President*); H. Hyams, J. A. Oriel, C.B.E., M.C., and G. H. Thornley (*Vice-Presidents*); Dr E. B. Evans, F. L. Garton, N. W. Grey, A. C. Hartley, C.B.E., E. C. Masterson, J. S. Parker, D. L. Samuel, O. F. Thompson, and C. S. Windebank (*Members of Council*); C. Chilvers (*hon. secretary*); D. A. Hough, T.D. (*general secretary*); G. Sell (*editor*); and E. Herbert (*technical assistant*).

Colonel Auld, proposing the health of Mr C. A. P. Southwell, emphasized his not infrequently expressed view that the greatest rewards in life were praise from one's own families and from one's own peers. There was no make-believe about that.

He was sure that was the feeling uppermost in Philip Southwell's mind then —the thought of being praised by his friends and the men "who know".

Mr Southwell must have had a lot of satisfaction in the success of his work and particularly when it had been on the scale of the oil production from Kuwait, said Colonel Auld. That had been so well timed. But his satisfaction never appeared to become self-satisfaction and his modesty had remained unimpaired and added to his other merits.

The toast was seconded by A. C. Hartley and drunk with enthusiasm.

Mr C. A. P. Southwell, thanking them for the way in which the toast had been proposed and accorded, referred in particular to his first meeting with Lord Cadman, who at that time was Professor of Mining at Birmingham University.

Among those who spoke during the evening were J. A. Jameson, Percy Anderson, J. M. Cooper, and Sir John Maude.

★ ★ ★

Council Commentary

At the meeting of Council held on 10 November, Col S. J. M. Auld was unanimously requested to accept office for a further year. In reply, Col Auld expressed his appreciation of this honour and said that he would continue in his efforts to widen and strengthen the Institute's contacts with the petroleum industry.

The next item was to receive results of the ballot for vice-presidents. This resulted in the nomination of Dr E. B. Evans, E. J. Sturgess, and A. C. Hartley. These three gentlemen have served the Institute well over periods of many years and their wisdom and experience will be of great value to the Institute.

The report of the Branches Committee which was presented indicated that the position in this connexion was very satisfactory indeed. Not only are the Branches flourishing but there are suggestions to expand the Australian Branch and to initiate one in South Africa. Owing to the distances involved, the Persian Gulf Branch has found it difficult to operate with Sub Branches at Kuwait and Bahrain and Council approved the recommendation that the Persian Gulf Branch should be wound up and two new Branches created at Kuwait and Bahrain.

Dr G. M. Lees has agreed to act as the Branch Lecturer for 1955-56.

The Engineering Committee also had considerable progress to report, in particular that the Marketing Code is now in print and the Refining Code is practically ready for the printers.

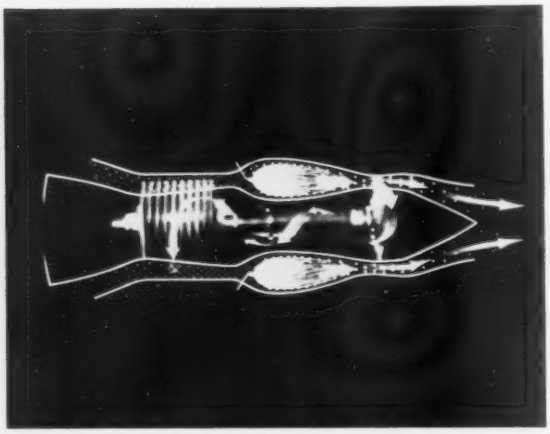
In conclusion, all members will be very pleased indeed to learn that the Honorary Treasurer, G. H. Coxon, was present, looking very well and obviously from his direct and vigorous comments fully recovered after his prolonged serious illness.

Books and Films

Motor Car History in Colour

In 1953 the Anglo-Iranian Oil Co. Ltd. commissioned Halas & Batchelor Cartoon Films Ltd. to make a colour film —*The Moving Spirit*. Now, the essence of this film has been reproduced in book form under the same title, and the development of road travel from the coaching days to the present era is traced by means of 47 pages of coloured cartoon.

Presumably designed for the younger members of the family, because included is a painting competition for children under 15, the book is sufficiently fascinating to hold the interest of the grown-ups as well. Page size is $9\frac{3}{4} \cdot 8$ inches and the price 5*s*. net. Publishers are Motor Racing Publications Ltd., 13 Conway Street, London, W.1.



"*The Gas Turbine*". *Diagram of a turbo-jet type gas turbine.*

Corrosion

Recently issued by Henry Wiggin and Co. Ltd. is a 34-page book entitled "Corrosion in the Petroleum Industry", the authors being Prof F. H. Garner, O.B.E., and A. R. Hale, Ph.D.

Also on this subject is the OEEC report on "Corrosion Problems and Prevention in the Chemical and Petrochemical Industries in the U.S.A.". The Mission whose report this is, visited the U.S.A. in 1953 and recommendations are made for the benefit of executives and engineers in Europe.

Statistics

The 1954 edition of the "World Petroleum Statistical Yearbook" made its appearance towards the end of last year. Within its 450 pages are much information and data of value to the petroleum industry. While, as is to be expected, the bulk of the publication is devoted to the U.S.A. there is a useful collection of statistics relating to other countries and to the world in general. The latest year for which complete details are given is 1953 in most cases, but some tables include figures for the first quarter of 1954. Price is $20, publisher is Mona Palmer, and copies are obtainable from 604 Fifth Avenue, New York 20, or 1 St. Paul's Corner, London, E.C.4.

The Dutch Floods

In the North Sea the great winter storm of 1953 breached many of the dykes in the South-West Netherlands, flooding vast areas of fertile land. This film, "View of Middelharnis", shows how 25 kms of dykes at Goeree-Overflakkee were repaired during the summer of 1953, how the machinery was brought in, the gaps sealed, and the dykes made ready to withstand the spring tides and storms of the coming winter. Made for the Royal Dutch/Shell Group with the assistance of the Regional Water Authority of South Holland, the running time is 20 minutes and it will shortly be available for distribution from the Petroleum Films Bureau in the U.K. and through Shell companies overseas.

The Gas Turbine

The simplest and most easily understandable portrayal of the basic principles on which the gas turbine works is given in the new Shell film entitled "The Gas Turbine". With a running time of 15 minutes, this film shows the principles on which both the plain jet and the shaft power-producing forms of this engine operate. By means of a sectioned gas turbine and animated diagrams the film explains how the gas turbine applies the same principles common to all heat engines, and it should do much to dispel many of the misunderstandings concerning the principles of this power unit. The film is available from the Petroleum Films Bureau, 29 New Bond Street, London, W.1, for loan in the U.K., and overseas from the Shell companies.

Motor Cycling Thrills

The thrills of motor cycling are brought to the fore by the three new films which Shell-Mex and B.P. Ltd. showed for the first time in London during the Motor Cycle Show.

First of these is entitled *The Dutch T.T.* and for 30 minutes the audience is shown the highlights of the four races which constitute the Netherlands Grand Prix, with some shots of the traditional fair on the eve of the event.

Similarly *The Isle of Man T.T. Sidecar International* is 11 minutes of excitement during the 1954 Sidecar International, this race having returned to the Isle of Man after nearly twenty years.

Tough Going, which is Motor Cycling Logbook No. 1,

A shot from "Tough Going".

illustrates the hazards of the three top events of the trial riders' calendar. In the Kickham Trial the hazard is mud, in the Scott Trial water, and in the Sunbeam Point-to-Point dusty moorland tracks.

All films are available on free loan from Shell-Mex and B.P. Ltd. Divisional or London offices.

Around the Branches

FAWLEY, LONDON, NORTHERN, PERSIAN GULF, SCOTTISH, SOUTH EASTERN, SOUTH WALES, STANLOW, TRINIDAD

Scottish Branch

A meeting of the Branch was held at the Institution of Engineers and Shipbuilders, Glasgow, on 9 November 1954, with Professor H. B. Nisbet, principal of Heriot-Watt College and vice-president of the Branch, in the chair.

Professor Nisbet, introducing the speakers, A. G. Frame, B.Sc., B.A., A.R.T.C. and L. P. Shortis, B.Sc., B.A., referred to their outstanding academic careers and mentioned how much Britain was indebted to the young chemical engineers who were shaping the pattern of the new developments in industrial production and application of atomic energy.

The lecture was entitled "The Rôle of the Chemical Engineer in the Field of Atomic Energy" and opened with an outline of the atomic energy cycle operated by the Atomic Energy Authority in Britain and the functions of the Authority's three factories, Springfields, Windscale, and Capenhurst.

The chemical and physical processes involved in the cycle were discussed in more detail, parallels were drawn with similar processes in industry, and attention was drawn to the additional difficulties involved when handling radio-active materials.

The work of the chemical engineer in the Authority's factories was summarized under three headings: (*a*) research and development, including production of a flow-sheet, (*b*) design and construction, and (*c*) operation of plant.

Research and development were discussed, mainly in the light of the work done in developing existing chemical plants, and design problems were also indicated.

Problems arise regarding operators handling radio-active materials and mention was made of the need for stringent safety precautions.

Finally, a brief description was given of the make-up of a nuclear reactor and the part played by the chemical engineer in development of "heterogeneous" reactors.

Questions were answered by both lecturers and a vote of thanks was proposed by the chairman.

Stanlow Branch

At a meeting on 24 September the chair was taken by H. E. F. Pracy, a vice-president of the Institute. This was Mr Pracy's last meeting before retirement and the Branch chairman, V. Biske, took the opportunity to express members' wishes for a long and happy retirement and to thank him for the good work he had done in furthering interest in the Institute in the area.

A paper entitled "Transport in the Oil Industry" was read by A. T. Hills and this was followed by discussion opened by J. A. Sheffield. Several members of the audience took part in the discussion and a vote of thanks to the speaker was then moved from the chair.

Internationalizing Petroleum Technology

On 18 October Colonel S. J. M. Auld, President of the Institute, spoke of international co-operation in the field of petroleum technology. The discussion was opened by D. H. Japes and a vote of thanks was proposed from the chair.

The Modern Oil Industry

A paper entitled "The Modern Oil Industry" was given by Dr Gustav Egloff of Universal Oil Products Ltd. on 25 October.

Dr Egloff opened with a short survey of the trends in motor gasoline quality and forecast an octane number of 100 in 1959.

This was followed by a more detailed description of the platforming process and an outline of the reactions involved.

Next, Dr Egloff spoke of the new Unifining process, seventeen units of this type now being under construction.

Finally, the lecturer went on to enlarge on the impact of the petroleum industry on the chemical field and illustrated this by a large number of samples which included synthetic fabrics, laminated nylon which could stop bullets, Acrolan simulated fur for lining pilots' clothes, etc.

South Wales Branch

Fire-fighting Techniques

At a meeting on 14 October, attended by members of the Branch and also, by invitation, by representatives from the Swansea Borough Fire Brigade and Glamorgan Fire Service, D. W. Thomas, superintendent of protective services, National Refineries Ltd., presented a paper entitled "Fire-fighting Techniques in the Petroleum Industry".

After discussing briefly the fundamentals of fire protection, Mr Thomas then considered fires in the industry, plant fires, and fires in storage and tankage. Plant fires, said Mr Thomas, were generally dealt with in the incipient stage by fire appliances used by process personnel. The different types of extinguishers used included steam for smothering and snuffing, and water used as sprays. The importance of a readily available supply of water for use as sprays for smothering and cooling and for the production of foam was emphasized and Mr Thomas then spoke of the results of work which had been carried out on the use of the alcohol-resistant type of foam compound in producing foam to combat M.E.K. fires. This showed the limitations of such foam in so far as it requires for its production water with a rather critical hardness.

Mr Thomas spoke of the many problems connected with tank fires and discussed various methods of fire fighting including the application of water, application of foam by top and subsurface methods, and oil or air stirring. Attention was directed to the zones in the fire; the flames, the vapour space between the flames and the liquid surface, the liquid surface, and the bulk of the liquid. The latter, said Mr Thomas, in some cases presented problems with hot-zone-forming oils.

Reference was made to work on fire fighting which had been carried out at Llandarcy, by DSIR (Fire Research Board) on various aspects, and in America by the U.S. Naval Research Laboratory on subsurface injection and by the S.V.O.C. on air stirring methods.

A lively and interesting discussion followed the paper and a number of questions were answered by the speaker.

Ocean-going Tanker Practice

A meeting of the Branch was held at the Training Centre, National Oil Refineries Ltd., Llandarcy, on 4 November, under the chairmanship of T. F. Perry, when Capt R. Page gave a talk on Ocean-going Tanker Practice.

Capt Page, who is the British Tanker Company's senior marine superintendent, Bristol Channel Ports, opened his

lecture with reference to the essential need for tankers to avoid delay in port—"the ship does not truly fulfil her purpose," said Capt Page, "until she is steaming at full speed." He went on to describe the different types and sizes of vessels from the super tanker of some 30,000 dwt used for straight hauls of crude oil from the producing area to the refinery, to the small vessels of about 4000 dwt used for distributing products from refineries to a marketing area where the port might have shallow water or restricted space. In between the big and small ships a general purpose class of between 12,000 and 18,000 tons made up the bulk of the ocean-going traffic.

Capt Page briefly discussed draft and trim, dead-weight tonnage, displacement tonnage, gross tonnage, and net registered tonnage. He then went on to describe the disposition of bulkheads which form the ship's tanks and are designed to give stability in a seaway, efficient separation of different grades of oil, and strength to the structure as a whole. This was followed by mention of the pipeline, valving, and pumphouse arrangements, and of the navigating spaces on the upper bridge amidships. Capt Page then dealt with matters such as living accommodation and the situation of engines and boilers.

The lecturer described the captain's many duties and responsibilities—ranging from navigation and medical care to administration and training. His command is exercised through his chief officer and navigating officers for all matters relating to the deck department and through the chief engineer for the overall control of the engine-room department.

The activities and problems of the catering department were outlined and the facilities for the comfort and welfare of the ship's complement were described. Mention was also made of the varied stores and equipment that it was necessary to provide and of the formalities to be observed to comply with the complex Customs and consular requirements.

Then followed a brief description of navigation and the employment of pilots and tugs.

Capt Page said that the main jobs on clearing port in ballast were cleaning the ship and cleaning, gas-freeing, and de-scaling cargo tanks. On loaded passage the main job was painting.

The lecture ended with the showing of two films followed by a lively discussion ranging from navigation to sludge disposal.

Dr L. Thornes proposed the vote of thanks for a most interesting talk enlivened by several anecdotes from Capt Page's long maritime experience.

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Personal Notes

Dr H. G. Kugler, geological adviser to the Central Mining and Investment Corporation and Trinidad Leaseholds Ltd. in Trinidad, has been nominated as second Vice-President of the Geological Society of America for the year 1955.

The nomination was in recognition of the work done in the Western Hemisphere by Dr Kugler as a geologist.

Dr Kugler has had long and varied experience of geology in the Caribbean area. He went to Trinidad in 1914 and afterwards worked in Venezuela and British Guiana. He has been a Fellow of the Institute since 1933, and has interested himself constantly in the proceedings of the Trinidad branch.

J. Lillie-Costello, O.B.E., M.C., has been appointed public relations manager of Shell-Mex and B.P. Ltd. He is to be head of a newly-formed Public Relations Department which will extend the work previously carried out by the Press and Information Section of the Company's Trade Relations Department.

Mr Lillie-Costello previously carried out a difficult public relations task in West Africa, first as United Kingdom regional information officer, and later as director of the Gold Coast information services.

A. T. Proudfit has been elected a director of the Standard Oil Co. (New Jersey). Mr Proudfit began his career in the oil industry 35 years ago as a field worker and was president of the Creole Petroleum Corporation, Venezuela, until he resigned to take up his new appointment.

Mr Proudfit has been succeeded as president of the Creole Petroleum Corporation by **H. W. Haight.**

Sir Rupert de la Bère, Bt., K.C.V.O., M.P. has been appointed the first Vice-President of the Institute of General Managers. Sir Rupert is a managing director of Proprietors of Hay's Wharf Ltd. and other Companies.

D. I. Baddeley, M.A. has been appointed manager of Orobis Ltd. Mr Baddeley was formerly assistant chief chemist in the Lubricating Oil Department of the Anglo-Iranian Oil Co. Ltd.

Orobis Ltd. is a company jointly owned by The Distillers Co. Ltd. and the Oronite Chemical Co. of San Francisco, U.S.A., to manufacture in the U.K. and market Oronite lube oil additives.

K. P. H. Jeens, A.M.Inst.Pet., has recently been appointed pump and compressor engineer to his firm, Messrs E. B. Badger & Sons Ltd.

G. P. E. Howard, a director of Hayward Tyler and Co. Ltd. has recently resigned from his position as general works manager of the Company and has taken up a new appointment as general sales manager.

W. B. Dick and Co. Ltd. announce the appointment to their Board of Directors of **J. S. Rolph,** general manager Marine Department and **R. F. Baldwin,** general manager Electrical Department. Both appointments took effect on 30 November 1954.

H. W. Smith, formerly a director of Universe Petroleum before its amalgamation with FINA, is being transferred to the company's head office as fuel oil manager.

Guy Wiggins, at present fuel oil manager, becomes South East regional manager in place of Mr Smith.

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FOURTH WORLD PETROLEUM CONGRESS

The President of the Institute, Col S. J. M. Auld, has been appointed with other eminent personalities in the oil world to serve as a Vice-President of the Fourth World Petroleum Congress. Vice-Presidents from other countries are: J. Colomo (Mexico), Professor F. P. Malschaert (Belgium), Dr E. V. Murphree (U.S.A.), Professor R. Navarre (France), A. A. G. Schieferdecker (Holland), Dr G. Schlicht (Germany), Dr R. K. Stratford (Canada), and Dr G. Thery Fombona (Venezuela).

IP Conference on Molecular Spectroscopy

For the third time over 200 of the leading spectroscopists from the U.K., the U.S.A., and the Continent of Europe gathered together on 28-29 October 1954 under the auspices of the IP Hydrocarbon Research Group to discuss their problems. This year the subject was molecular spectroscopy and the conference was organized by the Spectroscopic Panel, the Chairman of which is Dr H. Powell. To assist him

Discussing the Molecular Spectroscopy Conference are Dr J. W. Barrett, Dr B. F. Dudenbostel, Dr H. W. Thompson, Dr H. Powell, and Dr L. A. Sayce.

in the organization he had the enthusiastic help of Dr H. W. Thompson, D. S. Lees, J. G. Reynolds, and G. N. Ross, secretary of the Panel.

The arrangement of the Conference was in four 3-hour sessions, the chairmen of the successive sessions being: Professor C. K. Ingold, F.R.S.; Dr H. W. Thompson, F.R.S.; Dr Van Zandt Williams, and Professor F. Morton.

In each session it had been arranged that the subjects of the papers were of a like character as far as possible. In addition, the opportunity was taken to devote a little time, at the end of each morning session, to a discussion of punched cards and the presentation of spectral data, and this discussion was initiated by Dr H. W. Thompson.

Papers Delivered

The Use of Fluorescence for Industrial Analysis and Examination. *By* E. J. Bowen, F.R.S., Physical Chemistry Laboratory, Oxford University.

Summary: The value and limitations of fluorescence observations for detecting and estimating substances were examined. General principles of measurement with special reference to fluorescence spectrometry were given and attention drawn to matters leading to error. The proper way of plotting fluorescence spectra was also discussed.

Spectroscopic Studies of the Phosphorescent States of Aromatic Hydrocarbons. *By* George Porter and Maurice W. Windsor, Department of Physical Chemistry, Cambridge University.

Summary: Many aromatic molecules on illumination pass to an excited metastable form which is identified with the phosphorescent state. By means of the technique of flash photolysis and spectroscopy, the absorption spectra of these labile molecules in degassed fluid solvents have been recorded for a large number of polycyclic aromatic hydrocarbons and also for many benzene derivatives. Lifetimes investigated lie between 10^{-5} and 10^{-2} sec, and are longer the more viscous the solvent medium. Decay of the phosphorescent molecule occurs, in solution, by a predominantly non-radiative process. The triplet state and other theories of the phosphorescent state were discussed, none being found to give a completely satisfactory account of the observed phenomena.

Raman Spectrometry: Instrumentation and Application. *By* B. F. Dudenbostel, Standard Oil Development Company, New Jersey.

Summary: A critical account of the present industrial application of Raman spectrometry was presented, together with brief details of experimental techniques and commercially available Raman instruments. The scope and accuracy of the Raman method was illustrated by the results of an analysis made to determine the total aromatic and total olefin contents of gasoline, and the C_5 and C_6 naphthene contents of refinery products.

Determination of Aromatic Hydrocarbons in Lubricating Oil Fractions by Far Ultra-violet Absorption Spectroscopy. *By* R. A. Burdett, L. W. Taylor, and L. C. Jones, Jr., Shell Oil Company.

Summary: The most intense absorption band system of the benzenes occurs in the region just beyond the lower wavelength limit of conventional photo-electric spectrometers. The intensity of this absorption band is independent of the number and location of alkyl substituents. This band system has been used for the determination of homologs of benzene in lubricating oil fractions and found to give results in good agreement with chromatography. Near ultra-violet absorption bands have been used for the estimation of the naphthalenes and phenanthrenes in the same oils.

Infra-red Instrumentation—Present and Future. *By* Van Zandt Williams, The Perkin-Elmer Corporation, Connecticut.

Summary: Specific infra-red instrumentation is available today for laboratory, pilot plant, and process control applications. The laboratory instrument meets *present* problem requirements as set by a centralized group servicing its own research facilities for "unknown" identification, molecular structure analysis, or quantitative multicomponent analysis. Future requirements include a simple, inexpensive infra-red spectrophotometer which the individual chemist can afford on a "standby" basis, an attachment for automatic measurement of integrated absorption coefficients,

The top table at the Dinner following the Molecular Spectroscopy Conference included (left to right) *J. G. Reynolds, Dr R. R. Gordon, Dr B. W. Bradford, Dr H. W. Thompson, Dr J. W. Barrett, Dr van Zandt Williams, Col S. J. M. Auld, Prof D. F. Hornig, Prof F. Morton, and Dr H. Powell.*

and a basic study of quantitative analysis to permit transfer of usable data from one site to another.

In general, the present status of pilot plant and process control infra-red equipment is well ahead of the ability of the industry to make use of such instruments.

Diffraction Gratings and Their Use in Infra-red Spectroscopy. *By* L. A. Sayce and A. Jackson, Light Division, National Physical Laboratory.

(Left) *Dr W. C. Price, Dr A. Bergman, R. A. Burdett, Dr H. Kaiser, and Dr R. Schurmann, and* (right) *R. G. J. Miller, Dr A. Salomon, P. Holliday, S. D. Farnsworth, D. S. Lees, Dr G. Nencini, and T. Jenkins at the Molecular Spectroscopy Dinner.*

Summary: Attention was drawn to the advantages of diffraction gratings compared with prisms in infra-red spectroscopy. Diffraction gratings can be made at low cost and used with simple slits and unfigured spherical mirrors. Provided inexpensive detecting systems can be made available, the way is open for infra-red monochromators to be liberally used for the general control of chemical processes. Gratings have another advantage over prisms in the ease with which dispersion can be controlled.

To eliminate unwanted short-wave energy when using a grating, a filter is used which is transmissive only to the required wavelength. The range of these filters has recently been extended.

Wastage of energy by diffraction in a variety of directions is minimized by shaping the grooves of the grating to concentrate the energy in one direction.

The Preparation and Use of Additively Coloured Alkali Halide Crystals as Infra-red Transmission Filters. *By* W. G. Burns, Hilger and Watts Ltd. and J. Gaunt, Chemistry Division, A.E.R.E., Harwell.

Summary: Crystals containing high concentrations of F-centres, made by heating alkali halides with potassium metal and cooling them quickly, have already been shown to have suitable characteristics for use as near infra-red transmission filters. The effect of controlling the cooling of such crystals has been studied, and it has been shown possible to vary the infra-red transmission from a sharp cut-in at about 1:2μ to a slow increase in transmission starting at 10-15μ, caused by very slow cooling. The extension of the visible absorption into the infra-red is accompanied by a decrease in the sharpness of the transmission edge. The outer layer of the crystal has also been shown to have a great effect in extending the infra-red absorption. Work on very thin sections has shown that in the centre of the crystal the effect of slow cooling is to cause the formation of R, M, and N centres, but at the edge the colloidal band predominates.

The use of such additively coloured alkali halide crystals as infra-red transmission filters was demonstrated and discussed.

Further Infra-red Measurements with a Cesium Iodide Prism. *By* E. K. Plyler, National Bureau of Standards.

Summary: Infra-red measurements with a cesium iodide prism have been made to 54μ. The single-pass and the Walsh double-pass systems were compared and their advantages noted. The transmittances of crystals of CsBr, TlBr-I, CsI, and of films of polystyrene and polyethylene have been measured. In addition, the absorption spectrum of three halomethanes and seven halobenzenes has also been observed. Prism spectrometry from 24 to 54μ with a CsI prism is handled by the same methods as those used with a CsBr prism.

The Pressed Disk Technique in Spectroscopy. *By* M. A. Ford, G. R. Wilkinson, and W. C. Price, King's College, London University.

Summary: Equipment for the production of transparent disks from alkali halide powders was described. The technique of using these disks for obtaining the spectra of solid materials finely dispersed within them, was discussed. The nature of the process was investigated with special reference to the production of good quality disks.

The Intensities of Vibrational Absorption Bands. *By* H. W. Thompson, F.R.S., St. John's College, Oxford University.

Summary: The significance of vibrational band intensities was explained and methods outlined for determining the true intensities from the "apparent" integrated band areas. The relative merits of molecular extinction coefficients at peak maxima, or of integrated band areas, were considered. Applications of measurements on band intensities were surveyed with particular reference to analysis and structural diagnosis, and typical values were collected for some key groups. The derivation of bond polar properties from band intensities was outlined and results of recent work outlined critically. Interesting conclusions were drawn with regard to the properties of C-H bonds. The limitations of this method were indicated and the importance of studying the electrical anharmonicity of bonds was emphasized.

The Characteristic Vibration Frequencies of Substituted Benzenes. *By* R. R. Randle and D. H. Whiffen, Department of Chemistry, Birmingham University.

Summary: Tables of the vibration frequencies, which appear to be essentially independent of substituent but depend only on the substituent positions, were given for all types of substituted benzenes. The frequencies were assigned as far as possible to the type of mode involved, C-H deformation, C-C stretch, etc.

The Infra-red Spectra of Some Mono-Deutero-Aromatics and Their Analytical Application. *By* E. D. Kunst, B.P.M. Laboratories, Amsterdam.

Summary: The infra-red spectra between 3μ and 15μ of several mono-deutero-aromatics were studied in order to develop a method for the determination of these compounds in the presence of their parent compounds. It appeared that some of the empirical rules correlating the spectrum with the type of substitution around the aromatic nucleus in alkyl aromatics remain approximately valid if one of the alkyl groups is replaced by a deuterium atom. The bands to which these rules apply and which lie in the region between 11.5 and 15.0μ are fairly intense and are very useful in quantitative analysis.

Spectroscopic Studies on the Oxidation of Hydrocarbon Mineral Oils. *By* H. Luther, Technische Hochschule, Braunschweig.

Summary: An apparatus was described for the study of the oxidation of mineral oils under carefully controlled conditions in a virtually closed system. Provisjon is made for the continuous measurement of the oxygen consumed and of the carbon monoxide and carbon dioxide contents of the gaseous reaction products. Liquid samples may be conveniently withdrawn for infra-red spectroscopic examination, or alternatively, the liquid phase may be circulated through an absorption cell for the continuous examination of absorption at a particular frequency. Aldehydes, ketones, and alcohol and lactones have been identified in the liquid reaction products and some of the results obtained were discussed.

Low Temperature Infra-red Spectroscopy. *By* N. Sheppard, Department of Colloid Science, Cambridge University.

Summary: An account was given of the applications of low temperature techniques to the study of infra-red spectra, with examples taken from recent work. Changes occurring in such spectra on passing from the gaseous to the liquid, or the liquid to the solid states, and on lowering the temperature in any one of these states, were described for rigid molecules. Additional effects which occur on change of state for flexible molecules exhibiting rotational isomerism were discussed. The applications of low temperature techniques to the spectroscopic study of molecular complexes and problems of qualitative and quantitative analysis were outlined.

Chemical Applications of Nuclear Magnetic Resonance Spectra. *By* R. E. Richards, Lincoln College, Oxford University.

Summary: Many atomic nuclei behave as though they possess a nuclear spin, and when placed in a magnetic field a number of energy levels become available to them. Nuclear resonance spectra occur when transitions among these energy levels are induced by radio frequency radiation. Interactions of different kinds occur

(Left) *J. Blears, Dr M. Robert, Dr J. D. Waldron, I. Favre, and W. J. Brown, and* (right) *Miss S. Hacking, D. Crowe* (in background) *Dr J. W. Barrett, Mrs. and Dr R. van Nechel.*

between neighbouring nuclei which broaden or split the energy levels, and from a study of these effects much information of interest to the chemist can be derived. The spectra yield information on molecular structure and internuclear distances in crystals, on the nature of chemical bonds and electron distribution in them, and on the potential barriers which hinder molecular motion in solids. The spectra can be used for the analysis of samples for different elements, for specific groupings in molecules, and for the analysis of mixtures. Rates and equilibria in chemical reactions can be studied and estimates of the rates of very rapid chemical exchange processes can be obtained. Many other important chemical properties can be studied, and the possible applications have not been by any means fully explored. Only very small amounts (1 to 0.001 cc) of material are used, which can be recovered unchanged after measurements.

An attempt was made to present a simple explanation of the processes which occur with particular emphasis on the chemical applications. Examples were given and the applications summarized. A brief description was given of the experimental method to indicate the sort of equipment used.

Spectroscopic Studies on Reactions at High Temperatures. *By* D. F. Hornig, Metcalf Chemical Laboratories, Brown University, Providence, R.I.

Summary: Strong shock waves may be used to heat substances several thousand degrees in times short compared to those required for chemical reactions. Such shock waves are often intensely luminous. Emission spectra from BrCN and ClCN show lines from CN and C_2; spectra of CH_3Br and CH_3I show a continuum, CH and C_2. Absorption spectra have also been obtained. Methods of following spectral changes through intervals of a few microseconds were described and results presented.

The Emission Spectra of Molecules and Radicals in the Infra-red. *By* G. R. Wilkinson, M. A. Ford, and W. C. Price, King's College, London University.

Summary: The infra-red emission from gases excited by an R.F. discharge has been studied in the region 1μ to 5.5μ. The conditions for maximum emission were discussed. Preliminary spectra were presented for several molecules, the essential features being the occurrence of high vibrational and rotational transitions, which should lead to more accurate values of the rotational constants. It was shown that the emission from HCl and CO form a convenient method of calibration of high resolution spectrometers. The favourable frequency factor occurring in the transition probability for emission enables overtone bands to be observed with a far smaller quantity of gas than that required in absorption.

Infra-red Absorption Bands of Hydrocarbons under High Resolving Power. *By* H. W. Thompson, F.R.S., St. John's College, Oxford University.

Summary: The objects of an analysis of vibrational-rotational absorption bands of polyatomic molecules, measured under high resolving power, were outlined, and the method compared with others leading to similar information. Some results obtained recently for simple hydrocarbons were considered in relation to each other.

The Interpretation and Use of Infra-red Reflection Spectra. *By* T. S. Robinson and W. C. Price, King's College, London University.

Summary: A description was given of the technique for obtaining infra-red reflection spectra from small samples of material, such as small crystals. The theory of the process was developed and it was shown how the absorption spectrum and the dispersion could be calculated from the reflection data. The method can be applied where the absorption is so strong that direct measurements of extinction coefficient are difficult owing to the small sample thickness involved. The use of polarized radiation gives information concerning the direction of certain bonds with respect to the crystal axes. Applications of the method to polythene, polytetrafluoroethylene, urea, and glycine served to illustrate certain features of the method.

Exhibition

Simultaneous with the Conference and in the same building was an exhibition of spectrometric equipment in which the following apparatus was shown and demonstrated:

Chemical Research Laboratory—Standard samples of organic chemicals.

Grubb, Parsons Ltd.—Double-beam infra-red spectrometer, type S-4, on console.

Hilger & Watts Ltd.—H 700 Uvispek photoelectric spectrometer; H 800 recording double-beam infra-red spectrophotometer; large aperture spectrograph for Raman spectra; accessories for infra-red work—liquid cells, variable path cells, etc.

Unicam Instruments Ltd.—Infra-red spectrometer; SP 500 spectrophotometer for ultra-violet and visible absorption measurement.

At the opening session, Dr J. W. Barrett, chairman of the Hydrocarbon Research Group, referred to the organization of the Group and pointed out that it was a body jointly financed by industry and Government. Its aim was to foster and support research on hydrocarbons and it had three panels —Spectroscopic, Mass Spectrometry, and Hydrocarbon Chemistry—each consisting of representatives of the sponsoring bodies and of universities where the research was being carried out. The Group was happy to be working with the Institute of Petroleum and to have the advantage of the services—secretarial, accounting, and editorial—which the Institute so readily gave.

This Conference, he said, had been organized by the Spectroscopic Panel and they were happy to have been able to make it international as regards papers and authors. They were also glad to welcome the four gentlemen who had undertaken to act as chairmen of the sessions.

The Conference Dinner

On the evening of 28 October the Conference Dinner, attended by nearly one hundred delegates, was held in the Waldorf Hotel, London, under the chairmanship of Colonel S. J. M. Auld, O.B.E., M.C., president of the Institute.

Welcoming those present, Colonel Auld said it was a great pleasure to be in the chair at this international gathering of men and women of the type, nature, and character of those present.

His first interest in spectroscopy was during the second world war. As chairman of the Enemy Oils and Fuels Committee it was his job to keep a tab on German aircraft fuels and lubricants. There was no difficulty in obtaining samples but methods of examination did present a problem. Two young scientists had suggested spectroscopy and that proved to be the solution.

Spectroscopists discussing their problems before dining. (Left to right) *R. A. Burdett, Prof F. Morton, Dr Van Zandt Williams, R. M. Sisson, Dr R. R. Gordon, Dr H. Kaiser, Dr H. Powell, Dr H. W. Thompson, Prof C. K. Ingold, Dr E. J. Bowen, Dr W. C. Price, Dr N. Sheppard, and A. Whittaker.*

Dr H. W. Thompson, of St John's College, Oxford, a member of the Spectroscopic Panel and the founder (now chairman) of the Pegasus Football Club, who proposed the toast of the Hydrocarbon Research Group, said it was a great privilege to do so. At the same time, he felt that he had to be careful what he said, for he was an Oxford Don and Oxford Dons were sometimes peculiar people. One of his colleagues recently spent half his time in the local mental home and the other half teaching pupils in College. Entertaining an undergraduate freshman one day to lunch he said "I'm giving you oysters today. You know my grandfather was an oyster, but I eat them just the same."

Dr Thompson said that he had known the Hydrocarbon Research Group throughout its whole existence, in fact from its very earliest conception during the dark early days of the last war. At the end of the war the oil companies had decided to maintain the Group to continue the work previously carried out under the auspices of the Ministry of Aircraft Production, and since that time it had considerably extended its strength and activities.

There had been much hard work along the way, he said, but also some fun. He mentioned an incident which occurred some years ago when he was lecturing on spectroscopy in Sweden, and was asked to see the Press. Asked what was the main factor in the development of infra-red work, he suggested that the real secret was the increased sensitivity of detectors. It was in fact like picking up the heat from a distant star, or as a friend of his had put it, picking up the heat from a chorus girl's blush at ten yards. Next day a heading appeared in a well known Stockholm paper "Oxford professor picks up heat from chorus girl's blush", and he was later invited to give a stage demonstration.

Reverting to the Hydrocarbon Research Group, he said that throughout, in spite of many changes of personnel, the policy had always remained sound and constant. The Group was a great example of co-operation between industry and the Universities and between the industries themselves. It was an honour for him to be allowed to ask those present to show their appreciation of the work of the Group.

The toast was enthusiastically received and Dr J. W. Barrett, Chairman of the Group, rose to respond and said he was delighted to do so as all members of the Group got much satisfaction from their task of organizing its work. The method of organizing research work varied throughout the world and the Hydrocarbon Research Group was unique in that it brought together a variety of bodies who agreed to give support to a diversity of subjects linked together by hydrocarbons.

Since the war the Group had dispensed over £100,000 on behalf of industry and at present was made up of four petroleum companies (Anglo-Iranian, Esso, Shell, Trinidad Leaseholds), two national bodies (Ministry of Supply and National Coal Board), and two chemical firms (Imperial Chemical Industries and Monsanto Chemicals). There was remarkable agreement between them and any differences were settled in the right spirit.

The Group appeared to be a unique and successful experiment in the field of sponsoring academic research. Perhaps its success would encourage growth of the Group and hence greater assistance to university research.

Dr Barrett said that the organization of the present Conference had given much satisfaction to the Group and to the Institute of Petroleum. The bringing together of so many people from so many countries to discuss techniques could only bring great rewards in all spheres. The Group had enthusiastic panels and a special vote of thanks was due to Dr H. Powell and his panel for the success of the Conference. He also wished to thank all those who had attended the Conference and Dr Thompson for his proposal of the Toast.

Dr H. Powell said that his work had been comparatively easy as his Panel was an excellent team. He took the opportunity of expressing his gratitude to them for the support they had given him during his chairmanship.

Our Overseas Guests

Professor F. Morton first expressed his pleasure and the pleasure of all of them in having the president of the IP at their dinner. Welcoming the overseas guests he said they brought ideas with them and he hoped they would take back news of development in the U.K. They would, he hoped, take the opportunity of examining the work in British universities and see the co-operation fostered not only between industry and universities but also between universities.

Professor Morton concluded by asking them to drink the health of the overseas guests.

Professor D. F. Hornig, expressing the thanks of the overseas delegates, said they much appreciated the chance to renew old acquaintanceships and make new friends. They were particularly struck by the fine example of co-operation shown by the work of the Hydrocarbon Research Group and he stressed the need for international co-operation on the same theme.

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SULPHUR AT GRANGEMOUTH

Further news about the new sulphur production plant commissioned at Grangemouth refinery, featured in the November 1954 issue of the *IP Review*, is that the unit referred to in the second paragraph of that article and in the illustrations was designed and built by Foster Wheeler Ltd.

A Reservoir Experiment on the Grand Scale

By Dr T. F. GASKELL*

The oil industry is a young giant among industries, and is still expanding. As peoples all over the world seek to raise their standard of living to that of the Americans, so they need to follow the United States in using more and more oil and oil products. The expanding oil industry must always be searching for new oilfields but the effort put into this must not be allowed to increase the price of oil unnecessarily. It is, therefore, important to know what reserves exist in known oilfields, and for this reason oil companies employ scientists to find out how oilfields function. They not only calculate the quantity of oil in the underground oil-bearing structure, but also determine how to bring the maximum quantity to the surface at the minimum cost.

Observations of fluid levels in the oilfields, and measurements of the properties of the oil and gas mixtures that comprise the crude oil in the underground reservoir, and of the rock that contains the oil, provide the basic data for calculations. Model experiments in the laboratory are used to extend the knowledge that theory provides about the behaviour of the oil in the rock, and checks are made by comparing forecasts of fall in oil level in a field against the observed values after production has proceeded for some time. A further check could be made if it were possible to stop production from a field for some months and to observe the changes in the fluid levels in the oilfield. This check would, as will be explained later, give information about the large-scale fissure structure in the underground reservoir. This fissure structure plays an important part in limestone oilfields, and it is difficult to learn much about it by normal field measurements or by laboratory experiments.

Limestone oilfields are among the greatest oil producers in the world, but limestone is not the only oil-bearing rock. There is another large group of oilfields in which the oil is held in sandstone, and the problems that arise in sandstone fields are not always the same as those that are discussed below. Sandstone rocks are often more uniform in texture than limestone, and small cracks or fissures in the rock do not play a great part in recovery of oil. Model experiments in the laboratory yield more information about flow of oil in sandstone than in limestone. Even so, with a sandstone field some useful data could be obtained by carrying out the full-scale experiment of shutting down the oil off-take and observing the changes in fluid level in the rock. However, with an expanding oil industry, it would be difficult to shut down production once the capital outlay of drilling wells and laying pipelines has been made. The scientist, therefore, has to be content to forecast the rise of oil level that would take place if an oilfield were shut down, without being able to check and amend his calculations by practical observations.

There is little doubt that the level of the oil in most reservoirs will rise if the oilfield is shut down. All the knowledge of reservoir behaviour that has been collected over the past thirty years indicates that oil is left behind as the liquid surface falls consequent on the oil being taken from underground up to the surface.

The oil in a limestone oilfield is not a pool of liquid like the village pond, but is held in the small holes or pores of the rock in the same way that water is held in a sponge. The holes are such that only about one cupful of oil is obtained from one cubic foot of rock. The oil that is brought to the surface through the well (which is a comparatively narrow six- or eight-inch hole drilled down into the oil reservoir) drains out of the porous rock and is led to the well by small cracks or fissures in the rock. The fissures need to be only a fraction of an inch wide to feed the well with a million gallons of oil a day. The fissures stretch back into the body of the limestone and collect the contributions of each cubic foot of limestone over a large area. Fissure systems are known to stretch for long distances because removal of oil from one well often affects the oil level in wells thousands of yards distant. This level is measured as the depth below ground

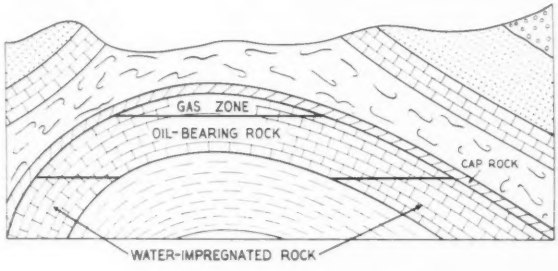

Fig 1. *A section across a limestone oilfield.*

surface (or more usually referred to some standard reference level) of the surface of the oil in a well which is drilled through the gas-dome of the reservoir into the oil (see Fig 1). This surface is determined by the liquid that can reach the well quickly from the fissures. When oil is being produced steadily from a field, the level falls at the rate of a few inches a day. This may be too fast for the oil flowing down through the finer holes in the reservoir rock, and so some may be left above what we are arbitrarily calling the oil level. A faster off-take would leave even more oil behind, but we still measure the oil level as the surface of the liquid in the well drilled through the gas-dome to the oil. Actually, the flow down a very small fissure of even $\frac{1}{1000}$ inch is fast compared with the few inches per day of drop in oil level, so that all the liquid in the fissures will follow the oil level in the observation well. What, however, happens to the oil in the porous rock? Much of this is contained in very fine pores about $\frac{1}{10.000}$ to $\frac{1}{100.000}$ of an inch in size, and the rate of flow in these pores is less than the rate of fall of oil level. Some of the oil that is draining down will, then, be left behind, and it is this that will provide an increase in oil level when a field is shut down. The oil left behind manifests itself in rock samples taken from above gas-oil level, and laboratory experiments on release of pressure around a piece of rock filled with oil and gas show that only a portion of the oil is expelled.

Some oil left behind will never drain down, just as a wet sponge will cease to drip water even when more water can

*The British Petroleum Co. Ltd.

be squeezed out of it. This is because the fine pores of the limestone or sponge hold a column of liquid by means of surface tension forces; the smaller the diameter of the pore the larger the column of liquid that can be supported against the pull down due to the weight of the liquid. If the column of liquid is longer than the vertical spacing of the fissures in the limestone no oil will drain down once the fissures have been emptied. The relative size of column height to fissure spacing to ensure draining depends upon the surface tension or stickiness of the oil to the limestone and on the size of the pores in the rock. The value of the surface tension can be measured in the laboratory, but it is necessary to make the measurements under the conditions pertaining in the reservoir, since the large quantity of gas dissolved in the oil of high-pressure fields affects the surface tension. Furthermore, the limestone contains small quantities of water, which, although probably confined to the small pores only, may form a thin film over the entire pore surface, thus preventing the oil from sticking to the rock at all.

The size of the pores in the limestone can be determined on samples from all the wells in an oilfield. The method, developed just after the war, is to force mercury under pressure into the rock and measure the volume of mercury that enters the rock at pressures varying from zero to several thousand pounds per square inch. Mercury does not wet rock as does oil or water, and its surface tension repels it from the rock so that a certain pressure of mercury is necessary to push it into a small pore; the smaller the pore size the greater is the pressure required. A pressure of 100 p.s.i. will force mercury into holes with a diameter of about $\frac{1}{25.000}$ inch, while 5000 p.s.i. will be enough for holes of one millionth of an inch diameter. The measurements show that the pore sizes in limestone rock vary from about $\frac{1}{1000}$ to $\frac{1}{100.000}$ inch, and that about one third of the pore volume is accounted for by pores larger than $\frac{1}{25.000}$ inch. This size of pore is an important one, because it corresponds roughly to a drainage rate equal to the fall of oil level when oil is being produced. We should expect most of the oil from larger pores than this to be collected by the fissures and fed to the wells. A small amount may be left behind due to capillary hold-up, which could be as large as 20 ft for holes $\frac{1}{25.000}$ inch in size, but which will be proportionately less for the larger holes. A further 20 per cent of the pore space is taken up by pores in the size range $\frac{1}{25.000}$ to $\frac{1}{50.000}$ inch, and the oil contained in these pores will drain at about 20 to 40 ft per year and will have a capillary rise of about 30 ft. If the limestone fissures are spaced only about 30 ft apart, this oil will not be recovered, but if the fissures are 100 ft apart then 70 out of a 100 ft of vertical column should drain down in about two years. This oil will cause a rise in oil level when a field is shut down, and the magnitude will be about $\frac{70}{100}$ of the 20 per cent of pore space, *i.e.* 14 per cent, compared with 34 per cent recovered from the large pores in normal production. The rise in level should then be nearly one third the normal annual fall in level. The figure of one third is obtained from the ratio of 14 per cent to the sum of 34 and 14 per cent, because, when the field is being produced steadily, it is obtaining a contribution from the limestone above the oil level just as it is when the field is shut down. The oil to be gained as extra on shut-down is that recently left behind in the limestone; the oil in limestone that is the equivalent height of two years above the falling oil level will have drained into its fissure system and will have been carried by the rapid flow fissures to oil level and thence to the well.

The simple example given above can be carried further because nearly half the pore space consists of pores smaller than $\frac{1}{50.000}$ inch. However, at $\frac{1}{100.000}$-inch pore size the flow rate is down to about 5 ft per year, and the capillary hold-up is increased to about 80 ft. Furthermore, there is evidence that the very small pores in the limestone contain water not oil, because when the oil originally entered the water-filled porous limestone it could only oust the water from the larger pores. It is clear, moreover, that the numerical value of the rise of oil level on shutting down of an oilfield depends very markedly upon the vertical spacing of the fissures in the rock, and that the calculation made above is for one hypothetical case only. Furthermore, it will be seen that a knowledge of the rise of oil level on shut-down will assist in making an estimate of the fissure spacing. Fig 1 shows that the oil is bounded on its underside by water and as the oil and gas are removed from the field the water rises, because the pressure drop disturbs the balance that had been established between the water, oil, and gas in the past. It is probable that the water level will rise when the field is shut down, because just as the oil can only drain down slowly through the fine pores, so the water can only move up slowly, pushing oil out ahead of it. The water pushes the oil from the fine pores to the fissures in a similar way to the drainage system in pores and fissures discussed above. There is evidence from laboratory experiments that in many fields a larger percentage is obtained from the rock by the pushing action of water than by drainage, and calculations can be made to assess how this will affect the change of oil level when a field is shut down. The calculation is based on the information available on pore size and fissures and from laboratory model experiments.

Pore size measurements provide a great deal of information about the internal working of the limestone oil reservoirs, but it is only by the tacit assumption that the pores behave as tubes through which oil flows that we can calculate, as we have done above, rates of drainage and capillary rises. The closeness of the concept of tubes to reality can be assessed by measurements on blocks of rock in the laboratory. This can be carried out on the small chippings of limestone that are brought to the surface when drilling a well, without the need for expensive core samples of rock, and if the pore size can be correlated with the observed behaviour of the oil reservoir, even by empirical relations, it will provide an important tool for oilfield studies. It is for this reason that the experiment of shutting down oilfields is important for advancing the knowledge of reservoir behaviour. It is an experiment that scientists would dearly have loved to carry out in normal production times, but the ever-increasing demand for oil and the economics of oil production have in the past made it impossible.

There should be no need to justify scientific experiments, especially in this year, which Sir Edward Appleton proposed should be one in which "Science for its own sake" should be the guiding theme of the scientist. It is however, a very useful and practical objective to learn more about oilfields. We know that some oil, probably quite a large percentage, is being left behind, and various ideas for "squeezing the sponge" and extracting all the oil from underground reservoirs have been proposed. For example, it may be advantageous to flush the oil from the limestone with water, as is being done in the sandstone oilfields at Eakring, or it may be possible to extract more oil by making some of the oil burn underground, as is being tried out in America. Before embarking on these schemes it is necessary to know the potential reward and the cost of the operation, and in order to make reliable calculations a proper knowledge of the working of the oil reservoirs is required. Well-conducted scientific experiments do not always result merely in ascertaining the facts that are in question; often they lead the observer to new ideas and in many cases it is these which are the more valuable. What to some were pointless pressure readings, led Captain D. Comins to formulate the principle of unit control of oilfields in Persia, at a time when there was little understanding of oil reservoirs in other parts of the world. It is time now that new impetus was given to laboratory research by making controlled experiments possible on full scale by shutting down an oilfield.

New Jetty at Kwinana Refinery

Last December the massive steel and concrete tanker berthing jetty being built on Cockburn Sound to serve Kwinana Refinery, Western Australia, was finished and the first tanker was expected to berth shortly after 1 January. About 500 men were engaged on the jetty which finally absorbed about 4400 tons of steel in its 936 boxed piles and 26,000 tons of concrete in its superstructure.

The 3,000,000 tons a year capacity refinery, which is being built by Australasian Petroleum Refinery Limited, the Australian associate of The British Petroleum Co. Ltd., is expected to be "on stream" early in 1955. Before commissioning, tankers will bring at least 50,000 tons of crude oil from Kuwait to be pumped into the storage tanks now rapidly taking shape on the site.

The jetty is L-shaped, the foot being a 1000-ft shore arm running out into Cockburn Sound. The longer side is an 1800-foot sea arm, set more or less parallel to the coast. The sea arm is built in 20 feet of water but, to provide the depth needed by large tankers, three short berths stand further out in water 40 feet deep at low tide. These short berths, parallel to the sea arm, are linked to it by concrete decking and banks of piping. The berths will take the largest tankers operated by the British Tanker Company, British Petroleum's shipping organization.

Construction Work

Since work on the jetty began in 1953 550 vertical steel piles and nearly 400 raking or bracing piles have been driven. A total of 122 concrete 14-ton main cross beams have been installed and 416 connecting beams have been placed in position. A 16-foot-wide precast concrete decking has been laid along the whole of the structure, and pipes connecting the tanker berths with the storage tanks have been installed along the 20-foot-wide pipe track running beside the decking.

When work started on the jetty over a year ago a fleet of more than 40 small vessels and rafts was assembled in Cockburn Sound. Two pile-driving pontoons, two large barges, and four crane pontoons, which have been used to lift steel piles into position for the pile-drivers, were shipped from the United Kingdom. Several different types of craft were built in Western Australia and others sailed from Sydney to Kwinana.

On shore a yard was established for the precasting of concrete beams and decking in special steel moulds. From the yard the beams were carried on a specially-laid railway line to the head of a temporary rubble and timber jetty, loaded into barges, and transported to the main jetty.

Before this, however, hollow steel piles, each weighing several tons and some of them 100 feet long, were driven deep into the sea-bed. The piles had to go down exactly where they were marked on the blueprint and this was achieved by taking the cross bearings of two surveyors' theodolites and driving the piles while the bearings were being made. Because of the accuracy achieved the subsequent placing of the cross-beams and concrete decking was relatively simple, the whole structure being put together like a big Meccano set. Huge high-tensile bolts, which were stretched by a patented pull-jack exerting a 42-ton pressure as they were tightened into position, locked the structure together.

A British Petroleum photo

An aerial view of the 1800-ft jetty.

From the face of each of the three berths protrude 16 massive steel shock-absorbing buffers. These buffers, each about three feet in diameter, have behind them a solid two-foot cylinder of rubber. Covering the buffers, which are fitted into 60- or 70-ton concrete blocks built into the berths, are hardwood fenders to prevent damage to tanker hulls as the vessels come alongside.

A British Petroleum photo

Completion of the final section of the 3000-ft main trunk way of the oil jetty.

Protective Measures

Before being driven all piles were coated with bitumen but this protective film is not enough to stop the sea water penetrating to the steel in places, causing rapid corrosion. To prevent this a cathodic protection system, in which magnesium anodes attached to the piles reverse the flow of electricity inherent in the corroding process, has been installed.

Rusting must also be prevented in the pipelines running from the refinery to the tanker berths, and here a recently instituted process is being used. Instead of being painted the pipes receive a non-rusting coat of metal only a fraction of an inch thick.

While the jetty has been taking shape two suction dredgers working 22 hours a day have been deepening the channel through two sandbanks at the entrance to Cockburn Sound. To provide sufficient clearance for tankers carrying up to 30,000 tons of oil to reach the jetty, dredging was continued to a depth of 38 feet.

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World Petroleum Statistics

World production of crude petroleum in 1953 was 6 per cent greater than in 1952 according to figures published by the U.S. Bureau of Mines.*

In the four tables reproduced here details are given of crude oil supply and demand, production of major refined products, bunker oil deliveries, and estimated domestic demand for major products for those countries where reasonably complete figures are available. In most instances demand has been calculated by the following formula: refinery production (including fuel oil consumed in the refineries), plus imports, minus exports, and plus or minus changes in inventories in those few instances where inventory changes were known. Bunker loadings are included in the demand of the countries where the loadings occurred and are not classified as exports.

The following definitions are given of terms used in the tables:—

Motor fuel—Includes aviation gasoline, other gasolines and naphthas from crude, and natural gasoline, alcohol or benzol blended.

Kerosine—Includes all grades of kerosine for power, lighting, and range use.

Distillate fuel oil—Includes gas oil, light diesel oil, and light heating oils.

Residual fuel oil—Includes heavy residuals used for bunkering or fuel under boilers.

Lubricating oil—Includes all grades of lubricating oil and oils used in grease manufacture.

During 1953, data on production of jet fuel were not inclusive enough to warrant a separate tabulation for that product. Accordingly the production of jet fuel is distributed among its components, namely, motor fuel, kerosine, and distillate fuel.

* *World Petroleum Statistics*—1953, prepared by J. V. Hightower, commodity-industry analyst, under the direction of H. J. Barton. U.S.B.M. WPS No. 67.

TABLE I

WORLD SUPPLY AND DEMAND—CRUDE PETROLEUM—1953

(Thousands of barrels)

Country	*Production*	*Imports*	*Exports*	*Crude runs to stills*	*Other demand and losses*	*Stock change*
NORTH AMERICA						
Canada	80,902	81,406	2,527	154,310	360	5,111
Cuba	17	2,963	—	2,903	—	77
Mexico	72,440*	—	3,289	66,886	5,400**	−3,135
United States	2,359,998	236,576	19,931	2,554,865	17,030	4,748
Total	2 513,357	320,945	25,747	2,778,964	22,790	6,801
Daily Average	6,886	879	71	7,614	62	18
SOUTH AMERICA AND CARIBBEAN						
Argentina	28,664	24,710¶	—	52,800¶	320¶	254
Bolivia	601	—	67	457	24	53
Brazil	915	1,487	—	2,320	30	52
Chile	1,264	—	1,128	187	12	−63
Colombia	40,307	—	27,438†	11,283	915	671
Ecuador	2,967	—	1,302	1,700	24	−59
Neth. Antilles	—	267,462	—	264,672	—	2,790
Peru	16,061	239	2,565	13,852	28	−145
Trinidad	22,346	16,554	2,345	37,378	60	−883
Uruguay	—	8,296	—	8,207	—	89
Venezuela	644,243	—	488,862	149,605	3,800	1,976
Total	757,368	318,748	523,707	542,461	5,213	4,735
Daily Average	2,075	873	1,435	1,486	14	13
WESTERN EUROPE						
Belgium and Luxemburg	—	24,735	—	24,320	—	415
Denmark	—	136	—	165	—	−29
France	2,561	164,812	—	167,571	32	−230
Western Germany	15,504	32,932	—	46,917	149	1,370
Italy and Trieste	656	95,813	—	95,242‡	25	1,202
Netherlands	5,688	50,643	—	56,720¶	53	−442
Norway	—	519	—	465	—	54
Portugal	—	1,082	—	824	—	258
Spain	—	11,191	—	10,480	—	711
Sweden	—	10,425	—	10,951	—	−526
United Kingdom	402	185,461	—	187,190	84	−1,411
Total	24,811	577,749	—	600,845	343	1,372
Daily Average	68	1,583	—	1,646	1	4

TABLE I

WORLD SUPPLY AND DEMAND—CRUDE PETROLEUM—1953—(CONT.)

(Thousands of barrels)

Country	*Production*	*Imports*	*Exports*	*Crude runs to stills*	*Other demand and losses*	*Stock change*
MIDDLE EAST						
Aden	—	—	—	—	—	—
Bahrain Island	10,978	61,707	—	72,856	90	−261
Egypt	16,501	442	—	16,961	94	−112
Iran	9,800**	—	370	9,300**	130**	—
Iraq	210,268	—	201,149	6,320¶	1,780¶	1,019
Israel	—	6,375	—	6,509	—	−134
Kuwait	314,592	—	302,998	10,557	206	831
Lebanon	—	4,070	—	4,070	—	—
Neutral Zone	—	—	—	—	—	—
Qatar	31,108	—	30,355	—	100**	653
Saudi Arabia	308,294	—	233,035	74,560	571	128
Turkey	179	—	—	79	100¶	—
Total	901,720	72,594	767,907	201,212	3,071	2,124
Daily Average	2,470	199	2,104	551	8	6
OTHER ASIA						
China	730**	—	—	700**	30**	—
Formosa	18	2,115	—	2,247	—	−114
India, Burma, and Pakistan	4,785	—	—	4,260¶	40**	485
Japan	2,101	37,281	—	38,997	34	351
Total	7,634	39,396	—	46,204	104	722
Daily Average	21	108	—	127	—	2
OTHER AFRICA						
Algeria	641	—	625	—	10	6
Canary Islands	—	8,386	—	8,489	—	−103
French Morocco	761	—	—	749	10	2
Union of South Africa	—	—	—	—	—	—
Total	1,402	8,386	625	9,238	20	−95
Daily Average	4	23	2	25	—	—
OCEANIA						
Australia	—	6,867	—	7,600	—	−733
British Borneo	36,855					
Indonesia§	76,899	5,244	26,211	90,638	800¶	1,349
Philippines	—	—	—	—	—	—
Total	113,754	12,111	26,211	98,238	800	616
Daily Average	312	33	72	269	2	2
TOTAL ABOVE COUNTRIES	4,320,046	1,349,929	1,344,197	4,277,162	32,341	16,275
Daily Average	11,836	3,698	3,683	11,718	89	44
USSR AND EASTERN EUROPE						
U.S.S.R.††	370,000**	—**	2,100**	363,000**	4,900**	—
Other Eastern Europe	82,100**	3,400**	—**	84,700**	800**	—
Total	452,100	3,400	2,100	447,700	5,700	—
Daily Average	1,239	9	6	1,227	15	—
WORLD TOTAL	4,772,146	1,353,329	1,346,297	4,724,862	38,041	16,275
Daily Average	13,074	3,708	3,689	12,945	104	44

*Excludes 1,657,000 barrels of natural gasoline.
†Excludes reduced crude, 4,636,000 barrels, delivered to pipeline and mixed with crude exported.
‡Includes bonded crude.
§Includes New Guinea production, 1,751,000 barrels.
‖Imports from other than British Borneo.
¶Partly estimated.
**Estimated.
††Includes Sakhalin.

TABLE II

PRODUCTION OF MAJOR REFINED PRODUCTS BY COUNTRIES—1953*

(Thousands of barrels)

Country	*Motor fuel*	*Kerosine*	*Distillate fuel oil*	*Residual fuel oil*	*Lubricating oil*	*Total major products*
NORTH AMERICA (Total)	1,375,638	146,907	569,431	521,026	54,610	2,667,612
Canada	66,692	9,820	29,323	35,755	1,641	143,231
Cuba	955	666	777	342	24	2,764
Mexico	15,980‡	6,670‡	7,100‡	34,950‡	400‡	65,110
United States	1,292,011	129,751	532,221	449,979	52,545	2,456,507
SOUTH AMERICA AND CARIBBEAN (Total)	101,671	39,593	83,387	309,632	3,051	537,334
Argentina	13,210‡	6,320‡	7,070‡	20,110‡	670‡	47,380
Bolivia	265	59	62	65	—	451
Brazil	810§	120§	230§	880§	—	2,040
Colombia	2,270	562	769	8,001†	63	11,665
Chile	74	11	51	45	—	181
Ecuador	588	165	335	597	—	1,685
Neth. Antilles	45,866	20,586	39,704	161,494	1,134	268,784
Peru	5,240	1,859	1,620	5,793	67	14,579
Trinidad	8,489	4,126	5,301	17,032	—	34,948
Uruguay	1,966	1,058	1,045	4,027	—	8,096
Venezuela	22,893	4,727	27,200	91,588	1,117	147,525
WESTERN EUROPE (Total)	162,714	24,749	120,020	247,220	9,332	564,035
Belgium	5,836	845	4,340	12,421	42	23,484
Denmark	—	—	35	8	—	43
France	45,864	2,751	31,308	69,961	2,696	152,580
Western Germany	18,430	402	13,419	6,383	3,072	41,706
Italy and Trieste	19,679	6,357	18,524	42,726	486	87,772
Netherlands	18,474	3,852	15,323	23,769	287	61,705
Norway	80	—	92	64	66	302
Portugal	171	123	189	322	—	805
Spain	2,695	299	2,041	5,133	—	10,168
Sweden	1,732	719	1,941	5,695	108	10,195
United Kingdom	49,753	9,401	32,808	80,738	2,575	175,275
MIDDLE EAST (Total)	38,771	21,493	35,302	100,027	—	195,593
Aden	—	—	—	—	—	—
Bahrain Island	18,008	8,543	11,777	32,514	—	70,842
Egypt	1,591	1,622	798	12,074	—	16,085
Iran	2,210§	1,390§	1,160§	4,210§	—	8,970
Iraq	1,020‡	970‡	440‡	3,690‡	—	6,120
Israel	1,368	801	1,106	2,980	—	6,255
Kuwait	305	84	2,144	7,774	—	10,307
Lebanon	986	499	682	1,815	—	3,982
Saudi Arabia	13,278	7,584	17,166	34,970	—	72,998
Turkey	5§	—	29§	—	—	34
OTHER ASIA (Total)	12,773	3,313	7,181	17,663	2,085	43,015
China	240§	60§	60§	300§	—	660
Formosa	685	286	288	818	—	2,077
India, Burma, and Pakistan	1,110‡	710‡	740‡	1,300‡	90‡	3,950
Japan	10,738	2,257	6,093	15,245	1,995	36,328
OTHER AFRICA (Total)	1,810	643	2,491	3,544	15	8,503
Algeria	—	—	—	—	—	—
Canary Islands	1,728	547	2,230	3,254	15	7,774
French Morocco	82	96	261	290	—	729
Union of South Africa	—	—	—	—	—	—
OCEANIA (Total)	25,635	9,182	27,917	26,970	107	89,811
Australia	3,022	11	1,152	2,536	107	6,828
Indonesia and British Borneo	22,613	9,171	26,765	24,434	—	82,983
Philippines	—	—	—	—	—	—
TOTAL ABOVE COUNTRIES	1,719,012	245,880	845,729	1,226,082	69,200	4,105,903
Daily Average	4,710	674	2,317	3,359	190	11,250

*From crude petroleum, natural gasoline blended and oils rerun.

†Includes reduced crude.

‡Partly estimated.

§Estimated.

TABLE III

ESTIMATED DOMESTIC DEMAND FOR MAJOR PRODUCTS—1953 (Thousands of barrels)

Country	*Motor fuel*	*Kerosine*	*Distillate fuel oil*	*Residual fuel oil*	*Lubricating oil*	*Total major products*
NORTH AMERICA AND CARIBBEAN						
Alaska and Hawaii	4,850	169	3,286	6,250	148	14,703
Canada	71,815	10,044	36,178	42,510	2,690	163,237
Central America	2,854	476	3,250	5,710	95	12,385
Cuba	4,955	670	1,664	10,153	218	17,660
Mexico	18,655	6,579	6,770	30,190	693	62,887
Puerto Rico	2,766	675	305	3,383	56	7,185
United States	1,230,629	120,998	493,224	564,933	40,481	2,450,265
Other West Indies	3,850	420	9,650	28,380	200	42,500
SOUTH AMERICA						
Argentina	13,880	6,330	8,080	31,750	1,015	61,055
Bolivia	508	97	226	474	8	1,313
Brazil	21,407	3,440	7,968	16,137	1,091	50,043
Chile	2,975	832	1,073	4,215	149	9,244
Colombia	5,296	1,023	1,228	3,386	120	11,053
Ecuador	808	165	349	685	23	2,030
Paraguay	332	96	42	3	13	486
Peru	3,875	1,524	1,203	4,637	92	11,331
Uruguay	1,925	1,104	1,118	4,400	73	8,620
Venezuela	9,527	2,479	5,403	12,829	213	30,451
WESTERN EUROPE						
Belgium and Luxemburg	8,205	873	5,521	7,534	625	22,758
Denmark	4,815	762	3,625	5,740	273	15,215
Finland	2,580	550	1,230	1,090	100	5,550
France	33,391	780	20,100	49,510	2,580	106,361
Germany, West	16,626	357	18,814	9,150	2,802	47,749
Greece	1,875	697	2,239	4,114	130	9,055
Iceland	350	30	415	535	31	1,361
Ireland	2,423	846	724	1,680	120	5,793
Italy and Trieste	9,756	2,095	9,943	32,250	1,029	55,073
Netherlands	6,899	1,697	11,520	12,380	425	32,921
Norway	2,710	574	5,130	6,215	248	14,877
Portugal	1,173	1,015	2,059	3,063	106	7,416
Spain	4,320	510	2,638	5,898	425	13,791
Sweden	8,663	2,840	13,165	14,057	535	39,260
Switzerland	3,724	275	4,938	1,195	195	10,327
United Kingdom	57,594	15,060	29,115	55,816	5,560	163,145
MIDDLE EAST						
Bahrain	122	74	1,342	7,444	14	8,996
Jordan	245	190	90	—	5	530
Iraq	1,035	1,070	481	3,464	130	6,180
Israel	1,424	1,110	1,137	3,620	110	7,401
Kuwait	306	81	208	7,551	1	8,147
Saudi Arabia	987	177	2,772	9,039	27	13,002
Syria-Lebanon	1,666	653	1,545	1,798	65	5,727
Turkey	2,686	1,705	2,120	325	326	7,162
OTHER ASIA						
Burma	780	350	250	270	60	1,710
Ceylon	1,200	584	1,243	3,130	50	6,207
India	7,960	9,230	5,420	5,880	1,030	29,520
Indo-China	2,784	352	566	515	150	4,367
Japan	13,049	2,140	3,212	29,480	2,410	50,291
Malaya	3,060	190	6,170	10,300	130	19,850
Pakistan	1,510	1,580	1,490	4,850	190	9,620
Thailand	1,390	520	780	570	90	3,350
AFRICA						
Algeria	2,122	480	1,771	5,563	138	10,074
Angola	262	35	85	61	26	469
Cape Verde Is.	3	3	465	2,630	1	3,102
Egypt	2,495	5,590	4,375*	17,188*	230	29,878
Ethiopia	360	70	60	20	30	540
Madagascar	407	94	124	23	41	689
Morocco, Fr.	2,788	382	1,127	1,789	119	6,205
Sudan	582	159	306	619	40	1,706
Tunisia	741	295	636	890	51	2,613
Union of South Africa	10,493	3,630	3,222	1,950	625	19,920
OCEANIA						
Australia	19,909	3,564	8,770	7,813	750	40,806
Indonesia	4,740	3,840	3,730	4,750	220	17,280
New Zealand	5,915	175	1,438	1,804	194	9,526
Philippine Is.	4,922	1,387	2,629	2,933	209	12,080
TOTAL ABOVE COUNTRIES	1,661,954	225,792	769,757	1,116,521	70,024	3,844,048
Daily Average	4,553	619	2,109	3,059	192	10,532

*Includes transit trade in ship bunkers.

TABLE IV

BUNKER OIL DELIVERIES TO VESSELS ENGAGED IN INTERNATIONAL TRADE—1953*

(Thousands of barrels daily)

Zone	*Gas, diesel, and other oils*	*Fuel oil*	*Total*
U.S.A. (Continental)	26.0	187.4	213.4
Canada	2.0	15.5	17.5
Central and South America	11.1	34.2	45.3
West Indies	30.9	92.2	123.1
West Africa	12.3	21.7	34.0
U.K and Irish Republic	18.2	51.2	69.4
N. Europe (Including French and Atlantic Ports)	27.4	44.0	71.4
Mediterranean (Including Spain and Portugal)	20.1	46.6	66.7
Middle East (Including Egypt, Red Sea, and Persian Gulf)	28.6	85.8	114.4
South and East Africa	4.3	13.2	17.5
India, Burma, and Ceylon	1.8	12.2	14.0
East and South Asia (Including Indonesia and Japan)	16.9	52.2	69.1
Australasia	3.9	12.6	16.5
TOTALS	203.5	668.8	872.3
Total Foreign	177.5	481.4	658.9

*Bunkers from British companies lifted in a country's overseas possessions may not be precisely allocated.

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A 55-foot long distillation column leaving the Croydon works of Metal Propellers Ltd. on its journey to the "Shell" refinery at Stanlow. The column is 2 feet 6 inches in diameter and contains forty "Shell"-patented" Turbogrid" distillation trays. It is the longest complete plant ever despatched in one piece by Metal Propellers Ltd.—licensees for the manufacture of "Turbogrid" trays.

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CRUDE PRODUCTION

	1954 *October*	*Jan-Oct.*
	Tons	
Iraq Petroleum Co. Ltd.—Kirkuk	2,170,746	19,747,802
Basrah Petroleum Co. Ltd.—Zubair	466,500	3,796,596
Mosul Petroleum Co. Ltd.—Ain Zalah and Butmah	106,311	1,070,909
Kuwait Oil Co. Ltd.	4,488,950	38,543,619

U.S. Natural Gasoline Plants

The total productive capacity of natural gasoline and cycle plants in the U.S.A. on 1 January 1954 was 926,021 b.d. according to a Bureau of Mines Report,* an increase of 114,000 b.d. over the previous survey in 1952. Major increases in capacity took place in Texas, Illinois, Oklahoma, Louisiana, and New Mexico, the absorption-type plant accounting for most of the increase. However, in 1954 there were 6 plants using a refrigeration process, compared with one in 1952.

Details from the report are tabulated:—

TABLE I

NUMBER OF NATURAL GASOLINE AND CYCLING PLANTS IN THE U.S.A., AND DAILY CAPACITY IN THOUSAND BARRELS

	1950	1952	1954
Absorption:			
Number	358	374	406
Daily capacity	432	562	692
Compression:			
Number	117	68	62
Daily capacity	20	25	22
Refrigeration:			
Number	3	3*	8†
Daily capacity	‡	9	18†
Combination:			
Number	30	29	14
Daily capacity	38	35	27
Cycling:			
Number	46	47	45
Daily capacity	158	181	167
Total:			
Number	554	521	535
Daily capacity	648	812	926
Shut-down: §			
Number	12	15	14
Daily capacity	3	4	7

*Includes 2 charcoal-type plants.
†Includes 2 charcoal-type plants, daily capacity 154 brl.
‡Charcoal, less than 500 brl.
§Included in total.

TABLE II

CAPACITY OF U.S. NATURAL GASOLINE PLANTS ON 1 JANUARY 1954

	Primary capacity, b.d.	*Fractionator capacity, b.d.*
Propane	176,135	25,866
Butane	109,330	31,201
Isobutane	22,498	5,728
Isopentane	5,053	3,407
LP-gas mixture	69,272	7,713
Natural gasoline and other products	543,733	80,636
	926,021	154,551
Operating	919,329	154,551
Shut-down	6,692	—

*"Natural Gasoline and Cycle Plants in the United States, 1 January, 1954", D. S. Colby and L. V. Harvey. U.S.B.M. Information Circular 7700.

Launching of s.t.s. Hyala

Mrs H. Bloemgarten, the Lady Sponsor, and Mr H. Bloemgarten on the launching platform.

On 16 November 1954 the s.t.s. *Hyala* was successfully launched for Shell Tankers Ltd. from the Port Glasgow shipyard of Messrs Lithgows Ltd. The naming ceremony was performed by Mrs H. Bloemgarten, wife of H. Bloemgarten, a managing director of the Royal Dutch/Shell Group.

British-Dutch Friendship

Acknowledging the toast of "The Ship and her Owners" at the dinner following the launch, Mr Bloemgarten said: For a very long time now there has existed the closest and most understanding friendship between the Dutch and the British people, and this has been exceptionally so for those of us who work in the Royal Dutch/Shell Group. For 50 years or so we have worked and played together—mostly worked—in complete harmony, and there has been forged between us an unbreakable chain which has progressively strengthened through times of war and through times of peace.

By virtue of the Royal Dutch/Shell merger we share with our colleagues in London their pride in this fine ship launched today: likewise we enjoy sharing in the business relationships which have been built up over such a long period between our colleagues in London and the shipbuilding companies of Britain.

In sharing the pride and prosperity we also share the problems and difficulties. I watch the conditions and the cost indexes and so on in Britain as carefully as I watch them in Holland, and I read with interest remarks made at ceremonies of this kind with regard to taxation, high building costs, and all the other horrors with which we are faced these days.

Conditions will change from time to time, but when you dig down deep you find one outstanding fundamental necessity regardless of the conditions of the times, and that is the need to achieve with one's available manpower the highest possible degree of efficiency and productivity.

Modernization of Dutch Yards

We in Holland have many problems which are peculiar to us and some which are parallel to yours, but there are some difficulties which are more pronounced here in England than they are in Holland.

One of these is that of modernization of our factories and workshops. Modernization is progress, and progress must be sought at all times if we are to keep up with the times and our neighbours. In the case of our shipbuilding yards in Holland, this progress was thrust upon us in the most vicious way. As the Germans were leaving, they blew up and virtually destroyed all the shipbuilding yards in Holland. At that time our shipbuilders viewed the scene with absolute dismay but if you asked them now I think they would freely admit, viewing the scene in retrospect, that this was one of the best things which ever happened to them. If they were to maintain the shipbuilding industry in Holland at all, it was necessary to rebuild their yards from nothing, and this they did. They were therefore able to equip themselves with the very latest modern machinery, to build large prefabricating sheds, and to provide additional facilities for their personnel and so on.

All photos by courtesy of Shell

T.e.s. "Helix", sister ship to s.t.s. "Hyala", pictured during sea trials in October 1953.

Decisions to invest large sums of money for progress are much more difficult to make when there is a choice, and at times great courage is required to look far into the future and act accordingly. Nevertheless, through the ages it has always been those who have had this courage who have come to the front and stayed there.

The final result of modernization is to reduce one's costs and thus be competitive with one's neighbours. I know of the great steps which have already been taken in Britain with this end in view, and you have my, a Dutchman's, best wishes for continued success in this field of endeavour because it is always healthy to have virile competition with which to cope, and I hope that your competition will never cease prodding us in Holland into even greater efforts than have already been made.

Owners and Builders Co-operation

Proposing the toast to which Mr Bloemgarten had replied, A. H. White, managing director of Lithgows Ltd., said it was an honour to propose the toast to *Hyala*, which had been launched so gracefully by Mrs Bloemgarten. The vessel embodied the latest developments in hull and engine design, many of which were due to the technical services of Shell Tankers Ltd.

The Shell organization was quick to tackle problems. There had been a serious shortage of sea-going engineers for a long time, but several years ago Mr Logan of Shell Tankers Ltd. and his colleagues had got down to the problem. They had asked Sir James Lithgow to co-operate—men had been placed in the engine works, and training schemes instituted in technical colleges throughout the country.

The Shell organization had also tackled the ship management problem on a grand scale very successfully over many years and it was a particular honour for Lithgows to welcome such men as Mr Platt and Mr Hulton.

S.t.s. "Hyala" about to take the water.

J. W. Platt, chairman, Shell Tankers Ltd., presenting Mrs H. Bloemgarten with a replica of the Hyala shell. In foreground, Lady Lithgow, and (extreme left) A. H. White, managing director, Messrs Lithgows Ltd.

Presentation to the Sponsor

Lady Lithgow (chairman of Lithgows Ltd.), welcoming the guests at the launch dinner, gave a special welcome to the ladies, who were all wearing a sprig of heather tied with tartan ribbon. She also expressed the welcome in Gaelic.

Speaking for all of them North of the Border to all from Holland and South of the Border, Lady Lithgow said they were honoured by having so distinguished a company to wish God-speed to the *Hyala*. She was very conscious of being a humble representative of a great body of men, and of women too, who had helped to build the vessel and who would fit and engine her. There was no easy way in shipbuilding. Those who built and finished a ship had a difficult task; those who managed and operated a ship also had their difficulties. It was only natural that they should come together in organization and she welcomed the co-operation and collaboration her firm had always had from Shell.

Lady Lithgow then thanked Mrs Bloemgarten for having come from Holland to perform the naming ceremony and launching of *Hyala*, and presented her with a diamond bracelet as a memento of the occasion.

Mrs Bloemgarten thanked Lady Lithgow for the opportunity of naming *Hyala* and for the gift which she had received.

Mr J. W. Platt then asked Mrs Bloemgarten to accept a specimen of the Shell *Hyala*.* Owing to its minuteness it had been necessary to mount it under a magnifying glass in order that it could be seen. For the same reason, a silver replica, one inch long, had been mounted alongside.

During the dinner the guests were entertained by an excellent display of Scottish country dancing.

The "Hyala"

Hyala is one of the fifty-two 18,000-dwt general purpose tankers of this class which Shell Tankers Ltd. have in service, under construction, or on order. Built to Lloyds + 100 A.1 "carrying petroleum in bulk" classification, the general features of these vessels are

Length overall	557 ft 0 in
Length between perpendiculars	530 ft 0 in
Breadth moulded	69 ft 3 in
Depth moulded	39 ft 0 in
Loaded draft	29 ft 8¼ in

**Hyala* is a univalve of the *Gastropoda* class and *Rissoidae* family founded by H. and A. Adams in 1854. It is colourless and minute and is commonly found in seaweed in European waters.

Deadweight	18,000 tons approx.
Gross tonnage	12,000 tons approx.
Nett tonnage	7,000 tons approx.
Cargo tanks	11 centre
	11 Port
	11 Starboard

Total cargo tank capacity 869,680 cu. ft. at 98 per cent full, approx.

Hyala has been built by Lithgow Ltd. and will be fitted with single screw, geared turbine engines by David Rowan & Co. Ltd. of Glasgow, who are also supplying the boilers. Her service speed is 14½ knots.

Among those who accompanied Mr and Mrs Bloemgarten at the launching ceremony were: J. W. Platt (*chairman, Shell Tankers Ltd. and a managing director of the Anglo-Saxon Petroleum Co. Ltd.*); Mr and Mrs A. S. C. Hulton (*managing director, Shell Tankers Ltd.*); Mr and Mrs J. H. Kirby (*director, Shell Tankers Ltd.*); A. Logan, O.B.E. (*director, Shell Tankers Ltd.*); Sir Alexander L. McColl (*chairman, The Superheater Co. Ltd.*); E. H. Larive (*marine manager, N. V. de Bataafsche Petroleum Mij.*); Mr and Mrs E. G. van Bloeme (*sales promotion manager, The Shell Petroleum Co. Ltd.*); and Mr and Mrs F. A. Keeling (*Shell-Mex and B.P. Ltd.*).

(Left to right) H. Bloemgarten, Lady Lithgow, J. W. Platt, Mrs H. Bloemgarten, A. S. C. Hulton, Mrs A. H. White, Mrs E. E. Doerrleben, and Mrs A. S. C. Hulton.

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Trade Literature

High-temperature Alloys

A data sheet has been published recently by Henry Wiggin and Co. Ltd. giving tabular information on Nimonic 90—a corrosion-resisting material suitable for springs operating at extreme temperatures.

Distillation Tower Internals

Glitsch "Truss-type" bubble trays and other types of distillation tower internals are among the products described in a new brochure of petroleum refining equipment, B.T. 54, recently issued by Metal Propellers Ltd. of 74 Purley Way, Croydon, Surrey.

Water Detecting Paste

A Specification (T.S. 241) for Water Detecting Paste for Dipsticks used for detecting water in fuel tanks has recently been issued by the Chemical Inspectorate, Ministry of Supply.

Gallenkamp Catalogue

A revised price list and addenda has been published by A. Gallenkamp and Co. Ltd. to bring up to date their 12th Edition Catalogue, Volume 1, General Section. Copies are available from the Company at Technico House, 17-29 Sun Street, London, E.C.2.

Steel Castings

An illustrated booklet is obtainable from The North British Steel Foundry Ltd., Bathgate, Scotland, which gives details of the Company's products and also contains reference data, such as B.S. specification tables and U.S. equivalents, for the assistance of buyers of steel castings.

New Leaflets

An interesting series of leaflets describing various equipment for handling materials, for pipeline construction, conveyance of materials, and lifting is available from the Hyster Company, P.O. Box 4318, Portland 8, Oregon, U.S.A.

OIL COMPANY ORDERS IN THE U.K.

The Oil Companies Materials Secretariat has issued the following statement of the value of orders for materials and equipment placed in the U.K. by oil companies during the period July to September 1954:—

	£
Geophysical and other exploratory equipment, etc.	1,100
Specialized equipment for oil drilling and production including oil casing, tubing, etc.	1,395,200
Specialized equipment for oil refineries etc. (not including pumps and valves)	891,700
Drum and can-making, filling and cleaning equipment, kerbside pumps, and other oil metering and dispensing equipment, etc.	386,300
Railcars, road tankers, aircraft refuellers, etc.	55,300
Drums, drumsheets, and tinplate	1,654,900
Tankage (including tank fittings)	462,000
Tubulars, pipe fittings, and valves (ferrous and non-ferrous)	2,172,900
Pumps, (excluding slush, oilwell, and kerbside)	400,600
Boilers, boiler house plant, and accessories, etc.	110,400
Electrical equipment—motors, generators, transformers, etc.	874,000
Instruments, meters, and gauges, etc.	261,500
Prime movers and compressors	399,800
Machine and hand tools, welding and miscellaneous machinery and stores	1,184,000
Ferrous and non-ferrous plates, sections, sheets, and bars	600,800
Automotive equipment, all types	876,600
Laboratory equipment and chemicals including hospital and medical supplies	214,100
Bulk chemicals, catalysts, barytes, etc.	3,916,000
Cement and other building materials and hardware, including timber	725,000
Commissary, general requisites for office, warehouse, household, club, and sports, etc.	1,139,400
	£17,721,600

Notes of the Month

Progress in U.K. Oil Exploration

Work has been begun by British Petroleum's D'Arcy Exploration Company on well No. 7 at Plungar, Leicestershire, following the discovery of oil sand in well No. 6 at a depth of 2853 ft.

In addition, a new test well site has been chosen at Faringdon, Berkshire, and a seismic survey party is operating around Trowbridge, Wiltshire.

"Electre"

Largest self-propelled craft to be seen on the River Seine is the motor tanker *Electre*, pictured here, which is owned and operated by one of Shell's French associates, Société des Pétroles Shell Berre. *Electre* was launched early in 1953 and is in service on the 100-mile journey between refineries in the Rouen area and oil depots, power stations, and large industrial plants in Paris.

She carries a cargo of up to 1450 tons of fuel oil compared

A Shell photo

The "Electre" passing through suburban Paris.

with the average capacity of 800-900 tons of other tankers on the Seine. *Electre* is 246 ft in length, 35 ft in beam, and has a draught of 9 ft 6 in. Special adaptations have been made to enable her to operate on the Seine where allowance must be made for sharp river bends and low bridges.

British Oilfield Equipment Co. Ltd.

Heenan and Froude Ltd. and The Brush Group Ltd. have sold the whole of the issued share capital of British Oilfield Equipment Company Ltd., which was jointly owned by them, to Cameron Iron Works Inc. of Houston, Texas, U.S.A.

The main business of British Oilfield Equipment Company Ltd. in recent years has been the manufacture and sale under licence of oilfield equipment to the specifications and designs of Cameron Iron Works Inc. As the licence agreement had only a short time to run, the directors of Heenan and Froude Ltd. and The Brush Group Ltd. agreed that it was in the best interests of their respective shareholders to accept an offer from Cameron Iron Works Inc. to purchase British Oilfield Equipment Co. Ltd. as a going concern.

British Oilfield Equipment Co. Ltd. will continue to operate under its present name and Edward Benjamin will continue as managing director.

Future plans include the expansion of manufacturing facilities and the manufacture and sale of additional Cameron products not at present being made in the U.K.

Flying Geophysical Laboratory

Three electronic systems for geophysical exploration have been installed in an aircraft used by Aeromagnetic Surveys Ltd., a member of the Hunting Group of Companies. The aircraft is a Canso amphibian plane operated by Kenting Aviation Ltd. It incorporates an airborne magnetometer, which records variations in the earth's magnetic field, a scintillation counter, which helps to indicate the presence of uranium in the earth, and an electromagnetic detector, which can directly locate "sulphide bodies" that may contain copper, lead, zinc, or nickel.

This new "flying laboratory" will enable comprehensive geophysical surveys to be carried out at considerably lower cost than the previous method of making the three types of survey separately. An added advantage is that the three sets of data will be more conveniently comparable, having been obtained on the same flight lines.

Co-operative research, development, and testing by companies associated with The Photographic Survey Corporation Ltd. of Toronto, were responsible for the creation of the newly equipped aeroplane. Instruments were designed and built by PSC Applied Research Ltd. for Aeromagnetic Surveys Ltd. who will supervise the survey use of the aircraft. Assistance in the modification of the aircraft was given by Kenting Aviation Ltd. and Field Aviation Ltd.

Weaste Refinery Extensions

Extensions which have increased capacity by 500 barrels per day have recently been completed at the Weaste refinery of Berry Wiggins and Co. Ltd.

The original installation was built in the early 1930's and is connected by pipelines to the Manchester Ship Canal where ocean-going tankers bring in the crude oil and coastal and other smaller craft load the refined oils.

Rearrangements have been made in the layout of the original installation to provide for new units. Head Wrightson Processes Ltd. have been responsible for the extension work.

U.K. Search for Natural Gas

Although natural gas was not found in commercial quantities as a result of the boring undertaken by the Gas Council near Crowborough Warren, Sussex, last year, the Council has decided that a seismic survey of the area should be made. The survey has already begun and it is hoped that as a result the Council may be able to decide on a site for a second well.

"Shell" Research Ltd.

Research assets and activities of the Royal Dutch/Shell Group in the U.K. are to be taken over by a new company—"Shell" Research Ltd. This new company will carry out work previously handled by the Shell Petroleum Co. Ltd. and its research activities will be co-ordinated with work carried out by the Group in Holland and the U.S.A.

Chairman of the Board of the new company will be H. Bloemgarten and Dr C. G. Williams will be a director and general manager.

Thornton Research Centre in Chester and the Woodstock

Agricultural Research Centre in Kent will come under the control of "Shell" Research Ltd. Research on a wide range of fuel and lubricating oil products, on bitumen, and on chemicals derived from petroleum, is carried out at Thornton. At Woodstock, an experimental farm with associated laboratories, work is carried out on fungicides, weed-killers, and insecticides for world-wide application.

Dutch BP Jubilee

Benzine en Petroleum Handel Maatschappij, Anglo-Iranian's Dutch subsidiary, celebrated the fiftieth anniversary of its foundation in November last year. Senior officials were present from the Company and associated companies on the Continent, including N. A. Gass, a managing director of Anglo-Iranian.

Founded in October 1904, the Dutch BP Company traded as a private undertaking for about ten years before coming under the control of the European Petroleum Union. Ten years later it became the property of the Olex Company of Berlin, which had then become a subsidiary of Anglo-Iranian. In 1937 Anglo-Iranian became the sole shareholder of the Dutch Company.

Aden Platformer

A platforming unit, the first to be commissioned in the Middle East, has come into operation at British Petroleum's Aden refinery. The unit has an annual capacity of about 500,000 tons a year, double that of the platforming units which are operating or under construction at other refineries operated by British Petroleum and its associates.

Only one other unit remains to be brought "on stream" at the Aden refinery—the autofiner in which sulphur will be removed from power kerosine.

New Shell Chemical Company

Shell interests in the Australian chemical industry are to be controlled by a new company, Shell Chemical (Australia) Pty. Ltd. The new company will have its headquarters in Melbourne; it will distribute chemicals and manufacture them locally as circumstances dictate. E. N. Avery, chairman of the Shell Co. of Australia Ltd., will be chairman of the new company and T. W. Henderson will be managing director.

This step brings Australia into line with France, Great Britain, and America where other Shell chemical companies have been formed.

A British Petroleum photo

An aerial view of The British Petroleum Company's oil harbour at Little Aden showing tankers at Berth No. 1 and Berth No. 3.

Congress of Pure and Applied Chemistry

The fourteenth International Congress of Pure and Applied Chemistry Covering Organic Chemistry is to be held in Zurich from 21 to 27 July 1955 in conjunction with the eighteenth Conference of the International Union of Pure and Applied Chemistry.

The scientific programme will consist of three types of lectures: Congress lectures; section lectures covering (*a*) theoretical and physical organic chemistry, (*b*) natural products, and (*c*) synthetic, industrial, and analytical organic chemistry; short scientific papers grouped in accordance with the subjects.

Further information about the Congress can be obtained from The Secretary General, XIVth International Congress of Pure and Applied Chemistry, Zurich 1, Switzerland.

A Refueller for Two-strokes

A still from the film introducing the "Petroiler".

Evolved by Shell-Mex and B.P. Ltd. and Avery-Hardoll Ltd., the "Petroiler" is a new device for delivering petrol and lubricating oil in predetermined proportions to vehicles with two-stroke engines. The device is in the form of a mobile pump, with tanks for petrol and two grades of lubricating oil, and delivers a correctly-proportioned mixture in quantities down to as little as half-a-pint. For lubricating oil the purchaser has the choice of two viscosities and it is understood that most manufacturers of two-stroke engines have approved one or other as suitable for their machine.

The British Petroleum Co. Ltd.

At an Extraordinary General Meeting held on 16 December 1954 the decision was taken to change the name of the Anglo-Iranian Oil Co. Ltd. to The British Petroleum Co. Ltd.

Exploration in Papua

A new test well is to be drilled in Papua by the Australasian Petroleum Co. Pty. Ltd. at a site 125 miles west of the present operations at Omati where two wells are being drilled.

The British Petroleum Co. Ltd. is associated with Australian and American interests in the exploration activities in Papua.

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INSTITUTION OF CHEMICAL ENGINEERS EXAMINATIONS

The Institution of Chemical Engineers has recently published new "Regulations for the Admission of Student, Graduate, and Corporate Members, and for the Examination of the Institution". These regulations contain the syllabuses for the examination which is to be held for the first time in 1956. The preliminary or Part I of the new examination will, however, also be held in 1955 immediately before the last examination in Papers C, D, E, and F, of the present examination as described in the Institution's pamphlet "Hints to Candidates". The closing date for entry to both the present and new examination is 1 June each year.

Further particulars may be obtained from the General Secretary, The Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1.

Petroleum Research at the Royal School of Mines

Although opportunities for the study of the occurrence of petroleum are extremely limited in Britain, the 1950-53 Research Report of the Royal School of Mines, London, points out that the country has an unrivalled assemblage of different types of sedimentary rocks and a wide range of structures. Thus it is possible to investigate problems analogous to those which confront the geologist in oilfields.

Stratigraphy

The study of sedimentary rocks leads to a better appreciation of the features by which they are recognized and correlated and to improved methods of study. The examination of certain areas has provided advanced training for students intending to enter the oil industry.

Electrical Logging

Electrical logs from a Venezuelan oilfield have been analysed and compared in detail, enabling geological structures to be precisely defined and important deductions made.

To provide knowledge for the interpretation of radio-active logs, data have been collected on the radio-active properties of sedimentary rocks. The use of sensitive portable detectors has shown that radio-active mapping can be of assistance in mapping the distribution of sedimentary rocks.

Experiments are being made in the use of radio-active tracers to observe the passage of oil through sands, to determine permeability, and to estimate oil content.

Crude oil characteristics

In order to determine whether or not oils in two or more superimposed reservoir rocks could have a common source, research on the nature and relationships of crude oils from Venezuela and Ecuador is proceeding. It entails fractionation, extraction, and the measurement of physical properties.

Reservoir Rocks

A study of reservoir rocks will indicate the extent to which oil can flow through pores and cracks to reach wells. An investigation of Venezuelan reservoir rocks has shown that they are extensively cemented by silica when buried below a certain depth. Where they are shallower, the rocks have carbonate cements which tend to be more abundant adjacent to shales which bound the sands, elsewhere the cementing material is barytes. Interstitial water and aqueous filtrate from drilling mud may reduce the rate of oil flow and experiments have been undertaken to facilitate expulsion of some of these liquids. Favourable results have been indicated.

★ ★ ★

Forthcoming Meetings

THE INSTITUTE

(*At* 26 *Portland Place, London, W.*1, 5.30 *p.m.—tea* 5 *p.m.*)

Insurance in the Oil Industry. A. T. Wright (British Petroleum Co. Ltd.) **12 January**

Applicational Research in the Petroleum Industry. C. G. Williams, D.Sc., M.I.Mech.E., F.R.Ae.S. **9 February**

The Modern Planning of Regional Surveys for Petroleum. P. Leicester, B.A. **21 February**

IP FAWLEY BRANCH

(*At Esso (Fawley) Recreation Club, Holbury*, 7.30 *p.m.*)

Engine Design as Influenced by Fuels and Lubricants. C. A. Beard, A.M.I.Mech.E., A.F.R.Ae.S. **14 January**

Annual General Meeting—followed by film show—"Corrosion in Action". **28 January**

Detergents from Petroleum. Dr S. F. Birch, A.R.C.S., D.I.C. **18 February**

IP LONDON BRANCH

(*At* 26 *Portland Place, London, W.*1, 6 *p.m.—tea* 5.30 *p.m.*)

Careers in the Petroleum Industry. E. L. K. Frost. **19 January**

Additives—their Functions Explained. N. E. F. Hitchcock, B.Sc. **23 February**

IP NORTHERN BRANCH

(*At Engineers' Club, Albert Square, Manchester* 2, 6.30 *p.m.*)

President's Address. Col S. J. M. Auld, O.B.E., M.C., D.Sc. **18 January**

Some Developments in Fuels and Lubricants for Jet Engines. C. J. O. Moorhouse. **15 February**

IP SOUTH-EASTERN BRANCH

(*At King's Head Hotel, Rochester*, 7.45 *p.m.*)

Hard Facing for Wear and Corrosion Resistance. M. Riddihough. **1 February**

IP SOUTH WALES BRANCH

(*At the Training Centre, National Oil Refineries Ltd., Llandarcy*, 5.30 *p.m.—tea* 5.0 p.m.)

Petroleum and Platforming. A. W. Jeffery. **6 January**

Annual General Meeting. **3 February**

IP STANLOW BRANCH

(*At the Grosvenor Hotel, Chester*, 7.30 *p.m.*)

The Outlook for the Oil Industry. G. P. Glass, M.A. **19 January**

Relations between the Petroleum Industry and Government. V. Butler, C.M.G. **16 February**

Other Societies

Discussion on Atmospheric Pollution. Opened by G. R. Peterson, B.A. The Institution of Electrical Engineers, London. 5.30 p.m., tea—5 p.m. **10 January**

The Investigation of Fluid Flow Problems by Model Techniques. F. A. Gray and A. D. Robertson. The Institute of Fuel, Yorkshire Section, Royal Victoria Station Hotel, Sheffield. 2.30 p.m. **19 January**

A Study on the Significance of the Bitumen Ductility Test. Dr. R. N. J. Saal. Society of Chemical Industry, Road and Building Materials Group, Institution of Structural Engineers, 11 Upper Belgrave St., London, S.W.1. 6 p.m. **17 February**

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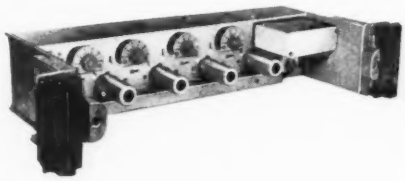

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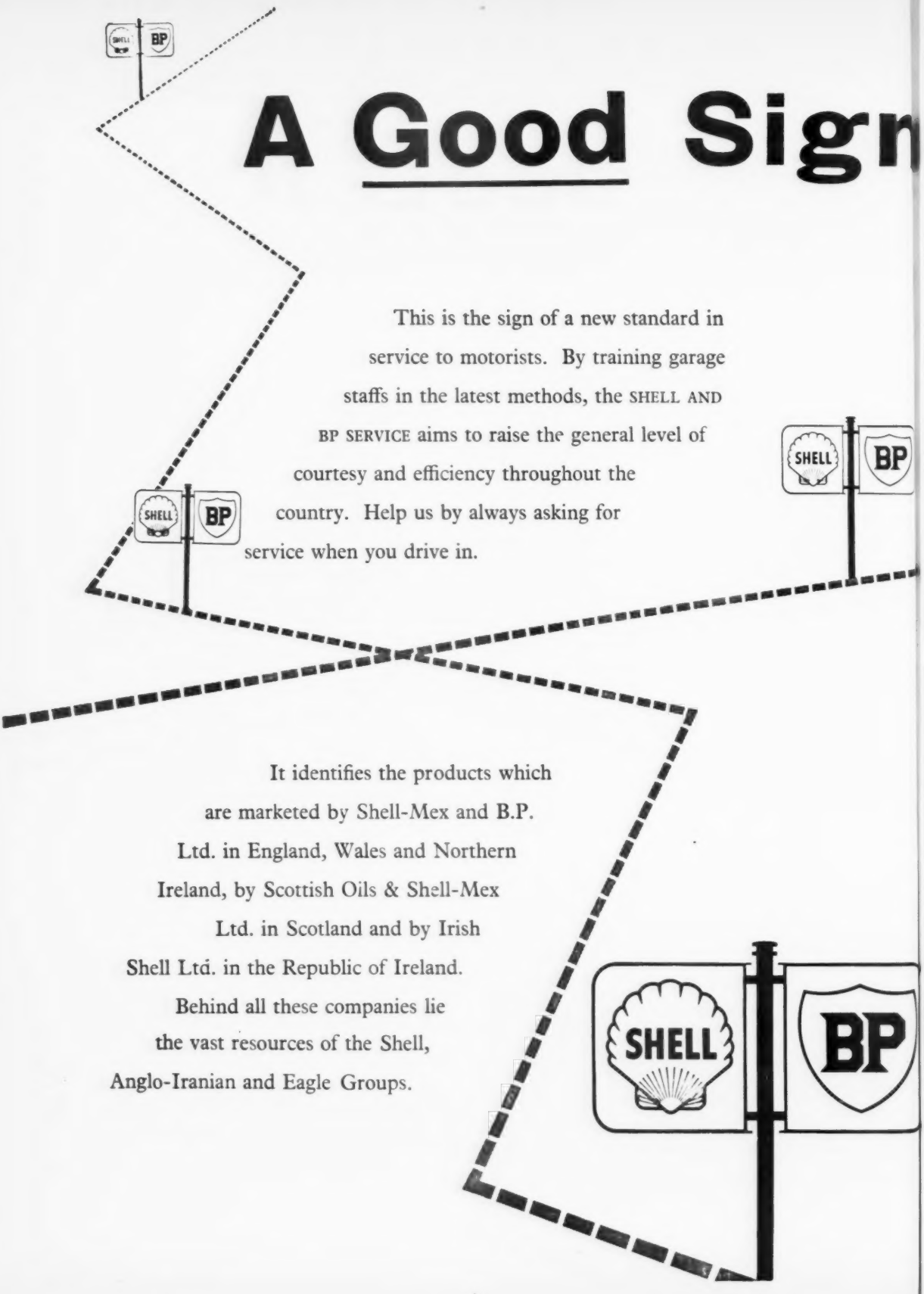

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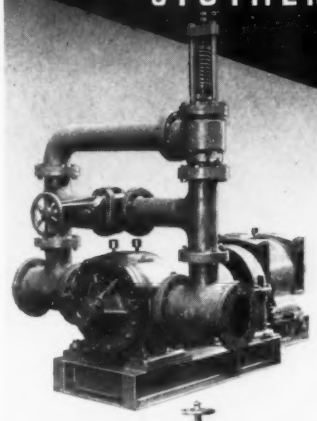

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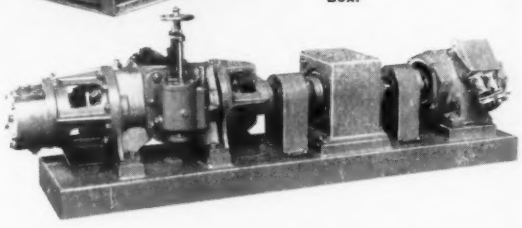
Positive Acting Rotary Displacement Pump for the handling of Molasses and viscous fluids, electrically driven through totally enclosed Reduction Gear Box.

(Below)
Positive Acting Screw Displacement Spirit Pump, electrically driven through Wall Box.



(Right)
Positive Acting Screw Displacement Spirit Pump specially designed for fitting to Road vehicles.

(Below)
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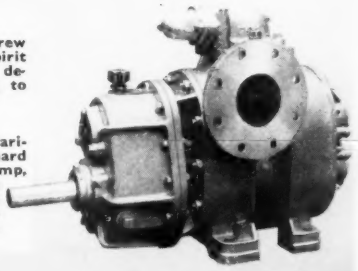

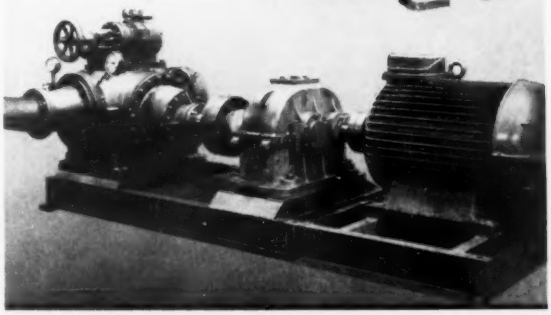

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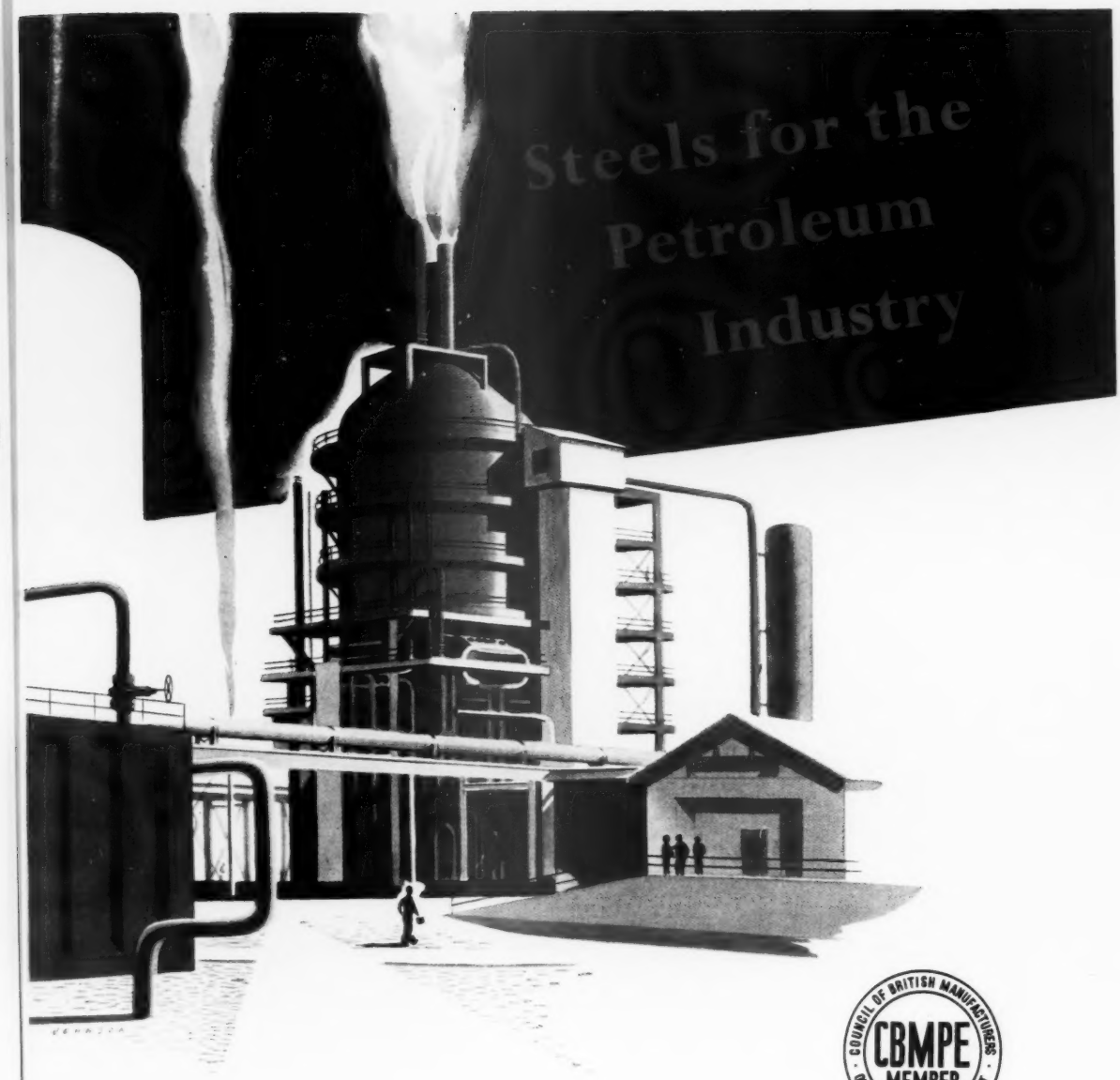

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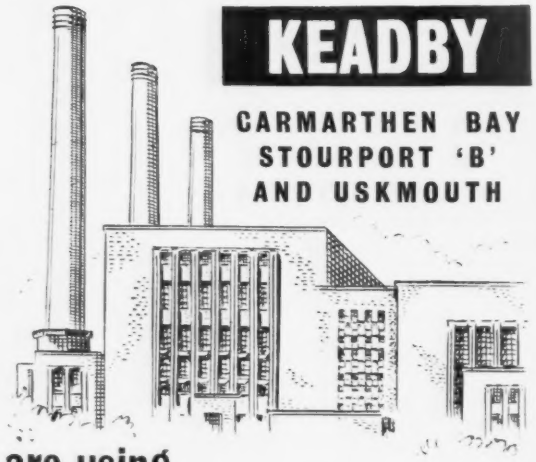

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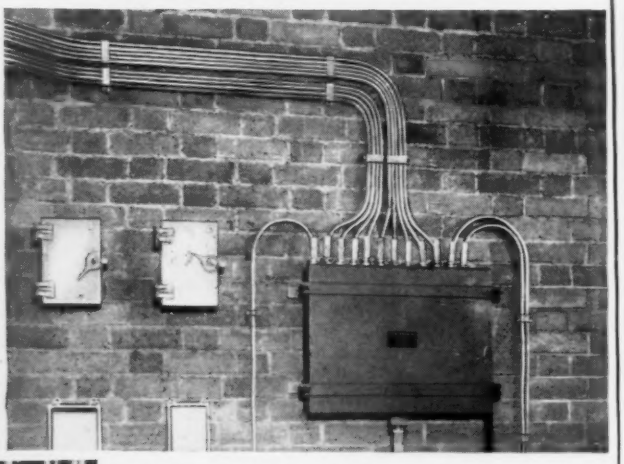

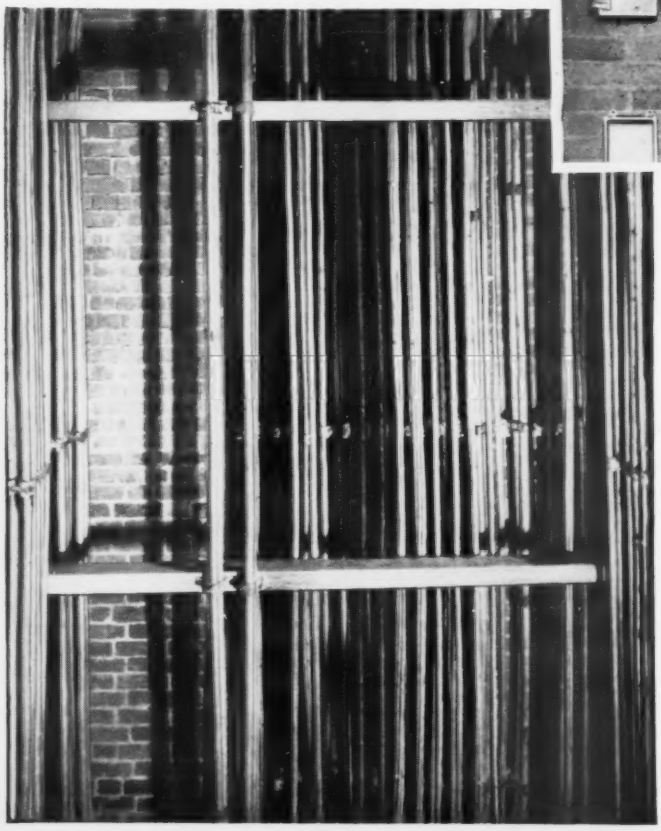

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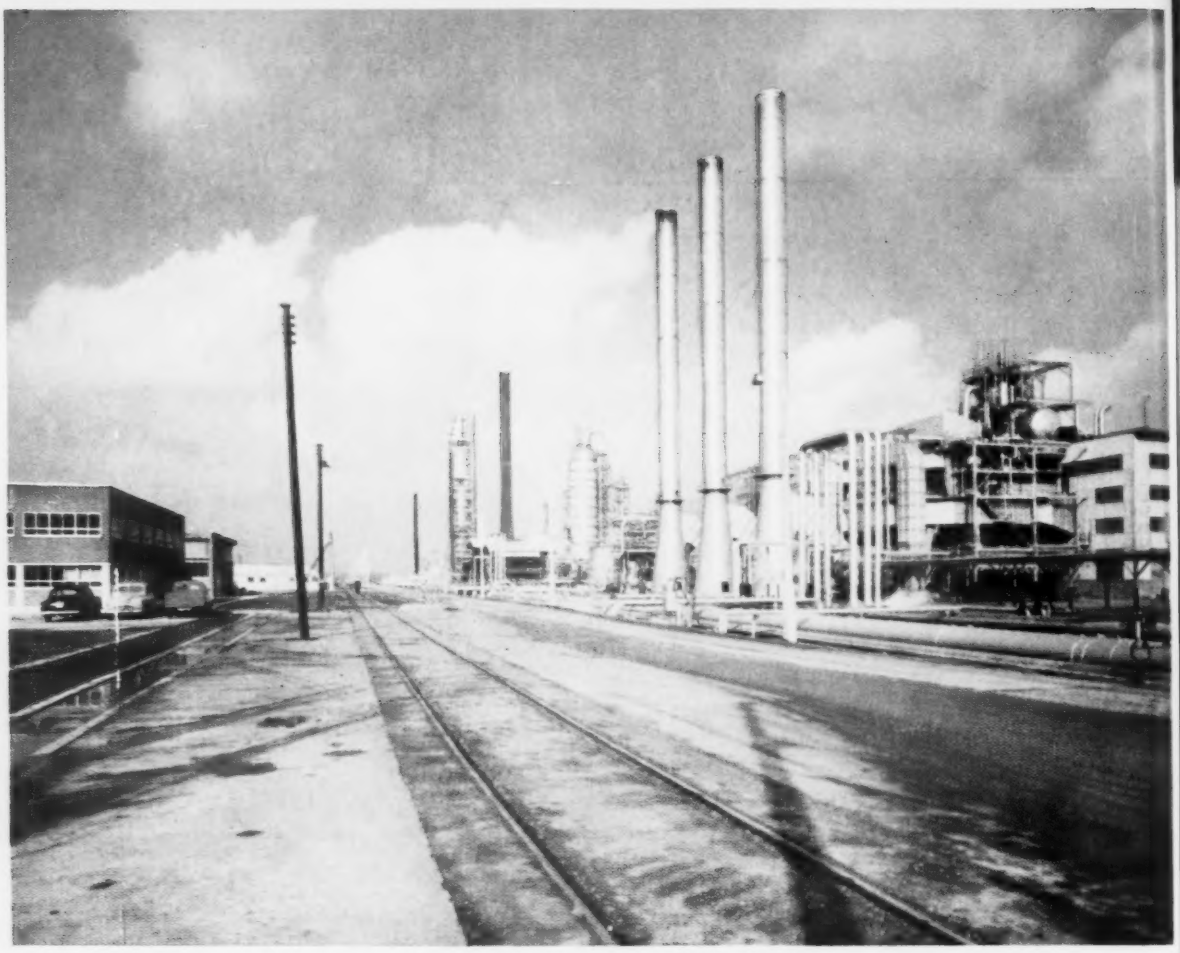

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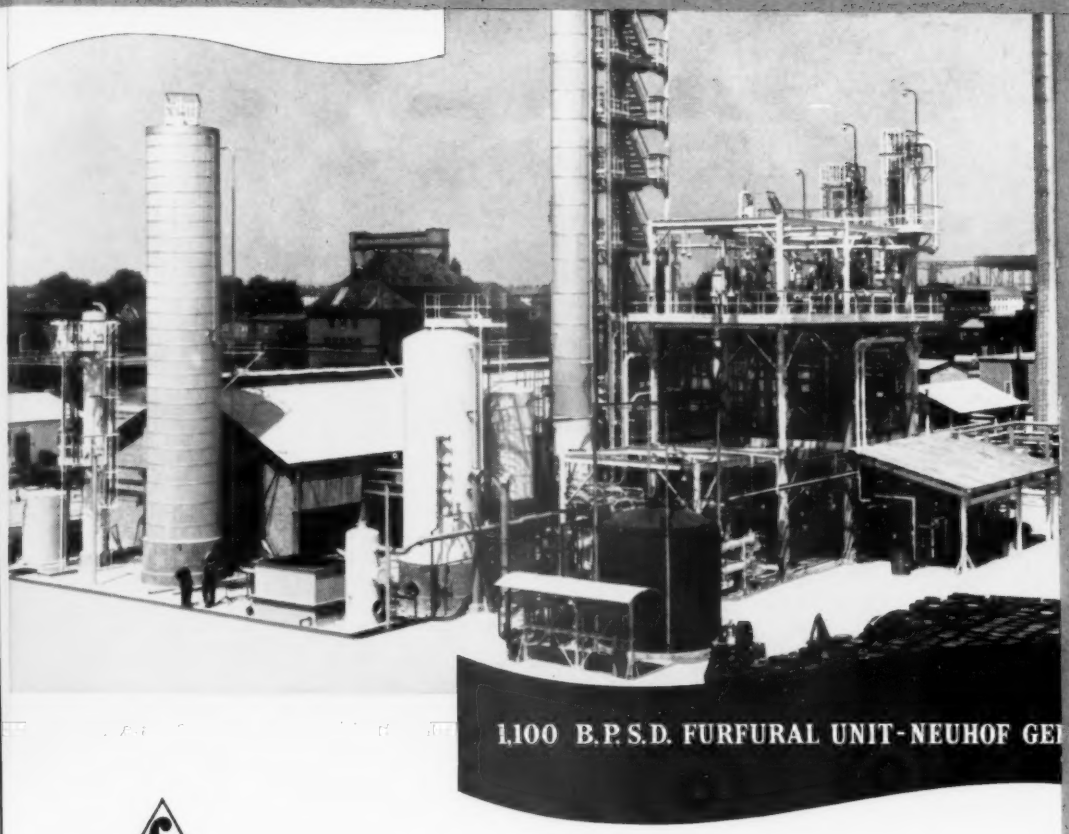

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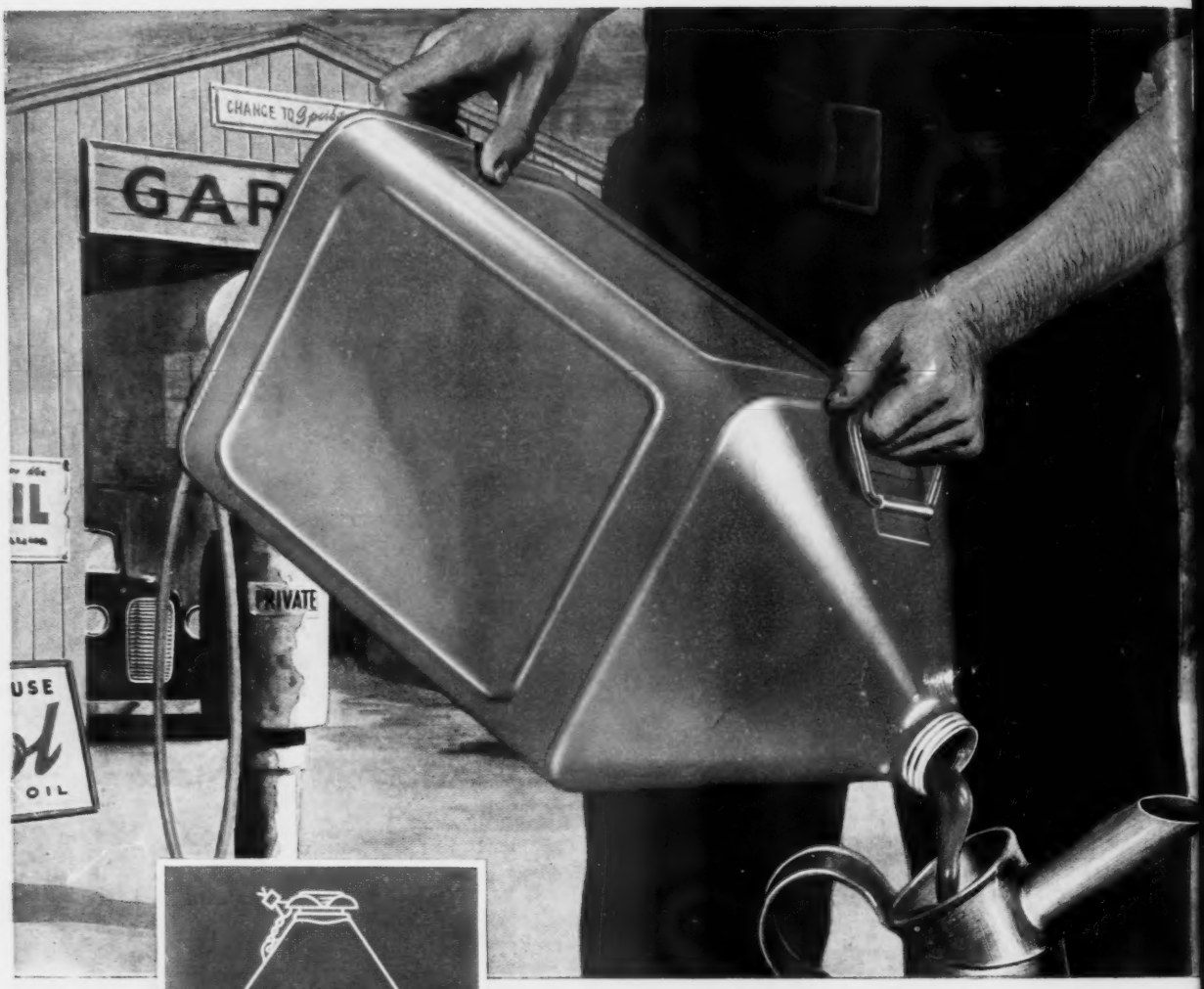

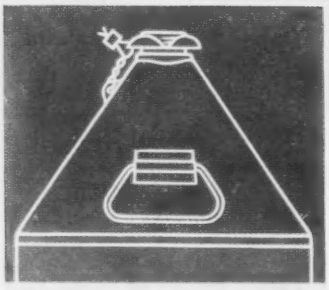

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